ISASC

EQUILIBRIUM®

QUARTERLY MAGAZINE OF THE INTERNATIONAL SOCIETY OF ANTIQUE SCALE COLLECTORS

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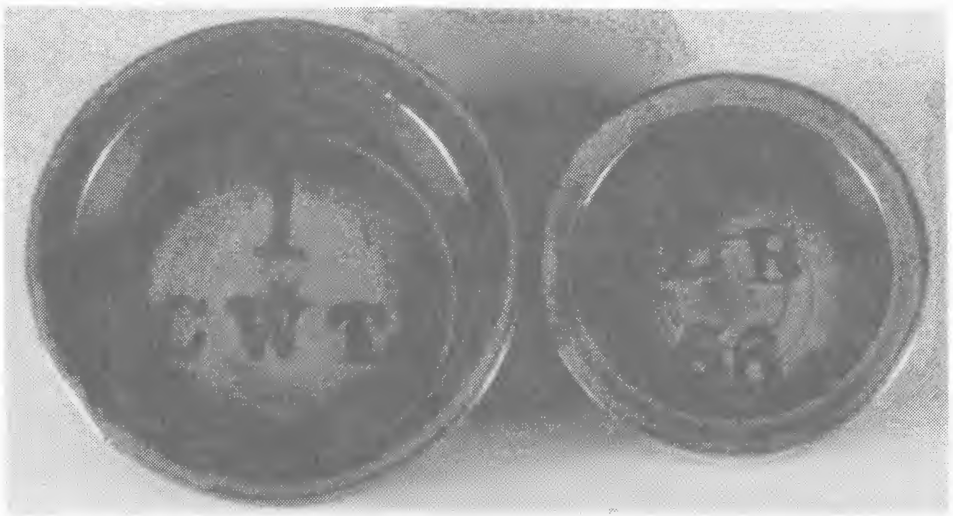
Cover Picture

The most appropriate commemoration of Lou Uit den Boogaard, who died on 15. 10. 96, must be to admire his excellent photographs of his collection, the cover picture being of one of his anonymous roberval postal scales, with weights for 2, 1, ½, ½ and ¼ oz, made in England during the second half of the 19th century. The engraved plates are exceptionally dainty.

The British proportional nesting weights below are characteristic of the unusual weights that Lou collected. He had many peculiar weights, Netherlands trade weights and Low Countries money-weights.



INTERNATIONAL SOCIETY OF ANTIQUE SCALE COLLECTORS

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Editor - - Diana Crawforth-Hitchins, 15 Hawthorn Ave., Headington, Oxford OX3 9JQ, England.
Associate Editor - - Ruth Hendricks Willard, P.O. Box 27565, San Francisco, CA 94127, USA.

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Bussey Questions

By P MOON

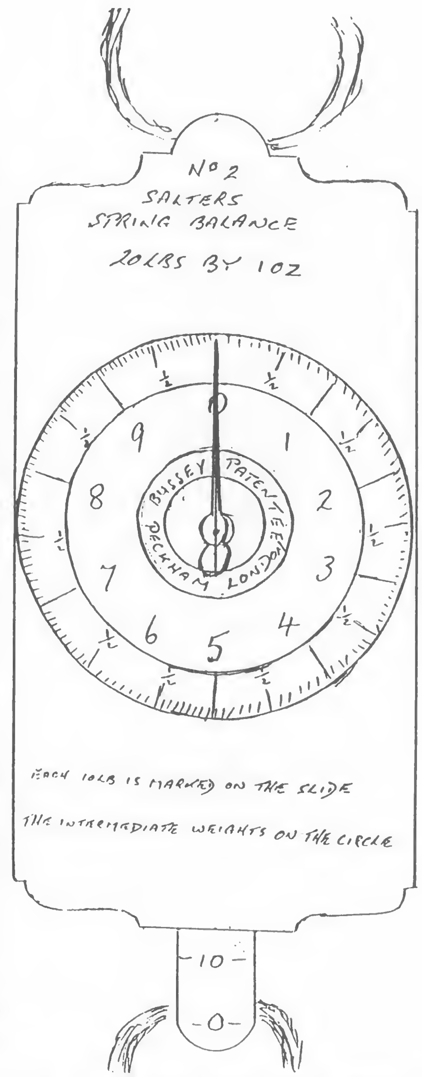


Fig. 1. Bussey Patentee, Salter spring balance, made before the knot was registered in 1884. Shown half size. Drawing P Moon.

I bought a Salter No. 2 (Fig. 1) because I was interested in the central boss stamped “BUSSEY PATENTEE PECKHAM LONDON”. Could Bussey be another of Salter’s employees, like John Silvester and John Hughes?

Salter’s had their factory in West Bromwich, a suburb of Birmingham, a hundred miles from Peckham in south-east London. So how could Bussey have been an employee?

Your editor put me onto the patent no 270, of 22nd Jan, 1879, (Fig. 2) taken out by George Gibson Bussey of Museum Works, Rye Lane, Peckham. (There was a Museum of Fire-Arms next to the new Railway Station of Peckham Rye.) The patent was easily missed, being for door-closers, blind-pulleys, mattresses, stirrup-leathers, etc., but in the small print of the detailed application “weighing machines” were mentioned. Did Bussey get most of his income from the manufacture of the former items?

I tried to get inside my Bussey patent balance, to see how the straps were attached, and to find out how much the springs would compress with a load. I was unable to remove the pointer, so I had to peer obliquely under the brass face. I could see no sign of straps or tension springs, to my disappointment. It appears to be of the same design as the editor’s drawing (Fig.3) of her early slide and dial scale, with two tightly-coiled springs attached to a bar that was pulled down by a load. So why did Salter acknowledge Bussey on the face?

Another member of ISASC, Arthur Buckhurst, was kind enough to draw his Bussey & Co. Parcel Post Balance (Fig. 4). Of course, I was hoping for straps and a tension spring, as it was stamped “PATENT”, but, again, it was a conventional spring, with a tube attached to the bottom of the spring, which stretched when the load was applied. So what was patented? And when did the firm become Bussey & Co.?

The Handbook of Old Weighing Instruments lists those letter-rates as valid from 1871 until 1897, so that a 7lb parcel would cost 8s::8d to send, which was an exorbitant amount. It was only reduced after

<u>Bussey’s Improvements in Springs for Door-closers, Blind-pulleys, Braces, etc.</u>

SPECIFICATION in pursuance of the conditions of the Letters Patent filed by the said George Gibson Bussey in the Great Seal Patent Office on the 22nd July 1879.

GEORGE GIBSON BUSSEY, of Museum Works, Rye Lane, Peckham, in the County of Surrey, Manufacturer.....

This Invention consists of improvements in springs suitable for door-closers, blind-pulleys, braces, and chest-expanders, mattresses, seats for chairs and couches, stirrup-leathers, paper and pocket-book bands, weighing machines, and nearly every other purpose to which tension springs can be applied.

The improvements consist in using a spiral spring of any shape, size and strength required, with the coils set well apart; through the inside of these coils two straps, bands, webs, or cords are made to pass, one each end of each strap, band, web, or cord being fastened to the last coil of the spring at each end. It is now clear that if the straps are pulled in opposite directions a very effective and cheap tension spring is produced, resulting from the effort of the spiral spring to recover its normal expanded state. Such springs are much more constant and durable than india rubber, also less likely to break, and less expensive than any other springs. The number of coils in each spring, the distance apart, the substance of the wire, depends entirely on the strength required and the purpose to which the spring is applied, but in all cases it should be made of the best spring steel properly hardened and tempered......

1883, when a proper Parcel Post rate was introduced, allowing a parcel of 1lb to go for 3d and one of 7lb to go for 1 shilling. Because the cheap-rate parcel-post was not mentioned on Arthur's balance, it seems reasonable to assume that the balance was made before 1883. So did the firm become Bussey & Co. before 1883?

Founders' Co. records show that a Frederick Bussey brought large quantities of weights to the Guildhall to be stamped in the 1840s. Was Frederick Bussey the predecessor of George Bussey?

Frederick Bussey had his brass foundry at 18, Great Mitchell Street, in St. Lukes, an area of London five miles due north of Peckham, on the other side of the City. Would a brass founder have made brass postal spring balances when the necessary skills were so different?

The earliest Avery catalogue, thought to have been produced about 1835, shows a Salter Improved Circular Spring Balance (Fig. 5) of the design that continued to be made right into the 20th century. So who made the first dial and slide balances?

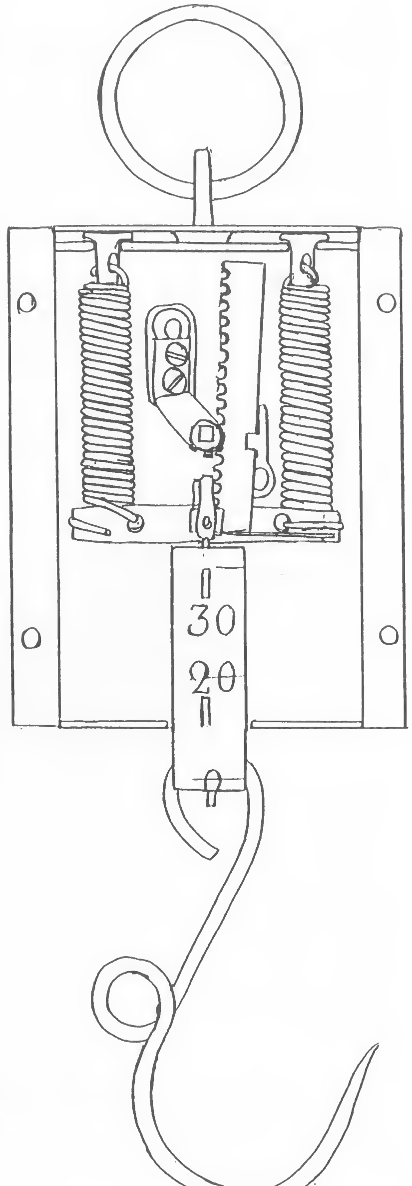


Fig. 3. Salter slide and dial spring balance. Made before 1884. Shown ½ size.
Drawing D Crawforth. ➢➢

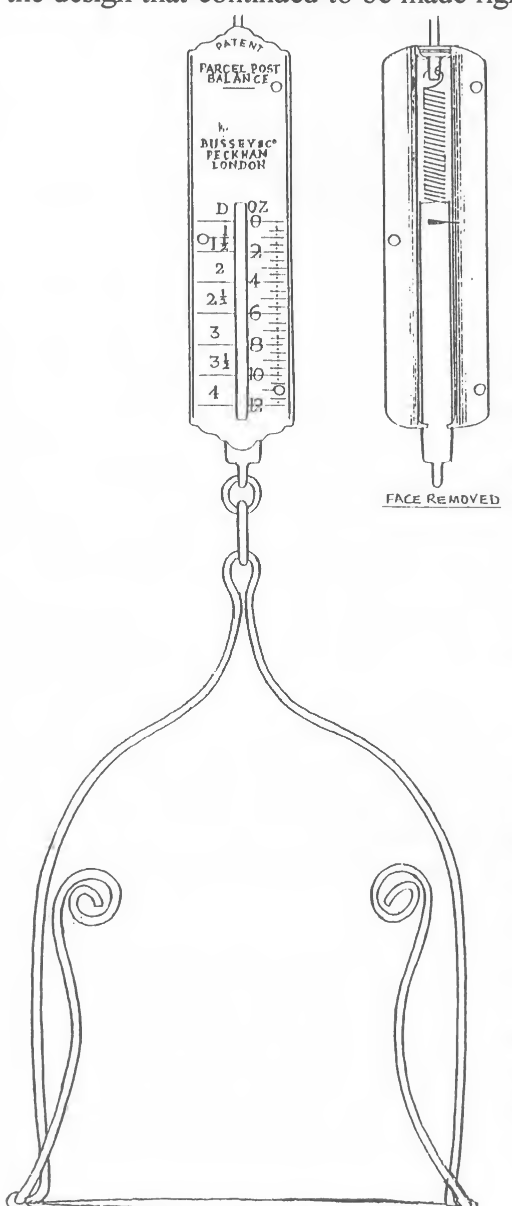


Fig. 4. Bussey & Co. Peckham, London. Parcel Post Balance. Rates for 1871-1883. Shown $^2/_3$ size.
≺≺ Drawing by A Buckhurst

George Salter took out patent no. 7724, on 9th July 1838, for "*improvements in the apparatus for weighing. These improvements relate to spring balances...and consist of 1st "In a method of indicating the weights by means of an index* [pointer] *and scale of divisions marked on the exterior of a tube of any required form, either curved or plane-sided.......*" This description fits the slide and dial balance, so could be the beginning of a highly successful product. Yet some doubts must be raised by the patent, because George Salter, in the same patent, laid claim to "*In the application of a hollow or tubular slide capable of admitting the spring*". Wasn't the tubular spring balance in regular production in Britain long before 1838? Was George Salter attempting to patent ideas that had been in production for many years?

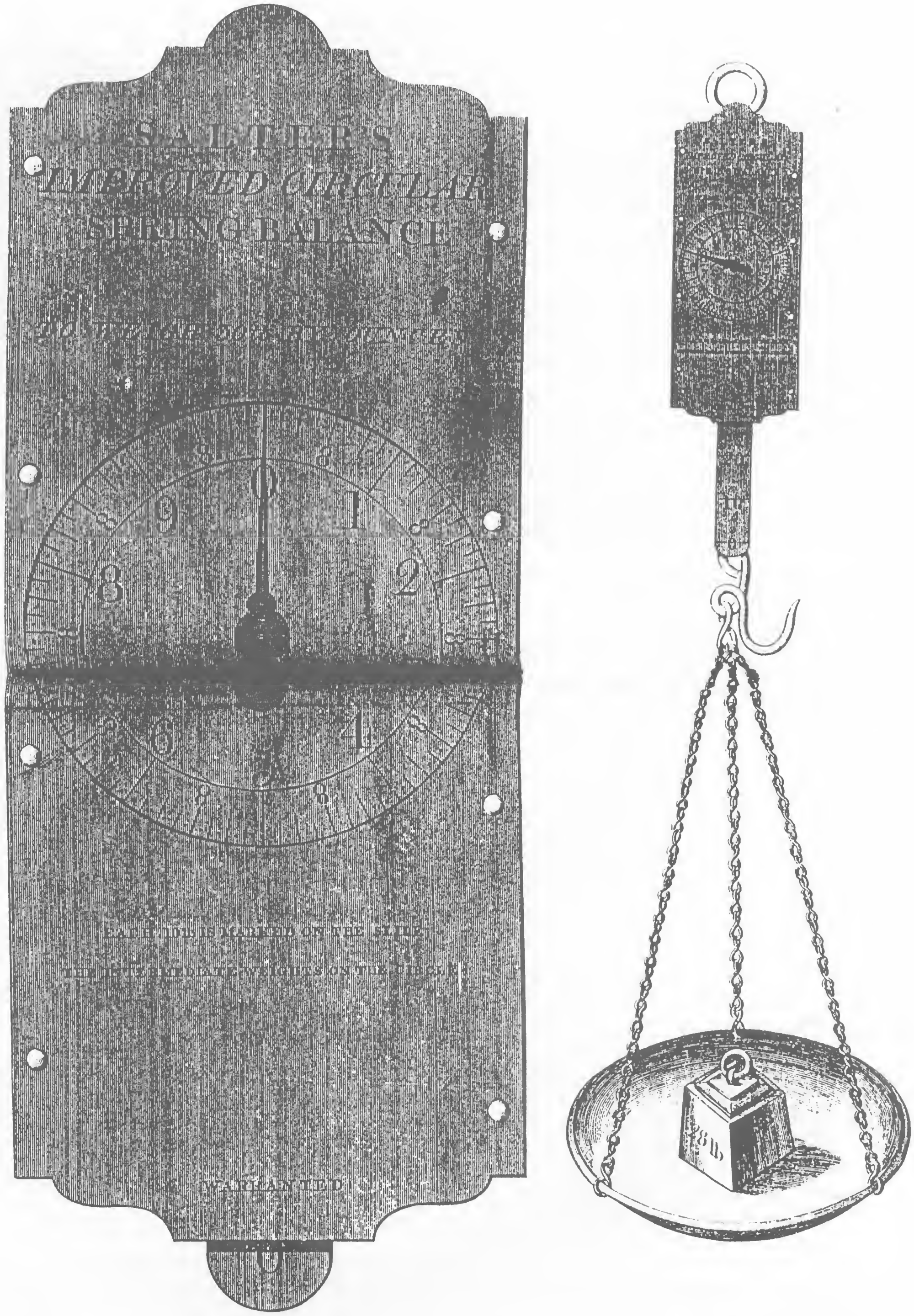


Fig. 5. Salter's Improved Circular Spring Balance, from the undated catalogue, circa 1830–35. (Called a slide and dial scale now). The first 10 lbs are read on the dial, then the increments above 10 lbs are read on the slide. Thus 20 on the slide plus 8 on the dial = 28 lbs.

The drawings in this catalogue went across the centre fold, so were distorted, and had heavy shadows in the photocopier.

Your editor has a record of William Martin's getting the silver Isis Medal and 10 guineas from the Society of Arts in 1813 for his Index Weighing Machine (Fig. 6). Although it had a slide, the index went round only once, thus indicating the full capacity without the need to show increments of the dial's capacity on the slide. Was this balance put into production? Was this the first dial-faced spring-balance to be produced in Britain? As is common once an idea "is in the air", another patent for a dial-faced balance was taken out by Jean Samuel Pauly shortly afterwards, in 1816. See EQM, page 1903.

The questions raised by this balance give some idea of why I bought this old balance. I hope that some members of ISASC can answer my questions and enrich my knowledge.

The SILVER ISIS MEDAL *and* TEN GUINEAS *were this Session voted to Mr.* W MARTIN *of High-St., Mary-le-bone, for an Index Weighing Machine. The following Communication was received from him, an explanatory Engraving is annexed, and one of the Machines is preserved in the Society's Repository.*

SIR: I have invented an improved method of weighing things of any nature, by a machine, which is very portable. The effect is produced by means of a helical spring acting within a case or tube, which spring contracts or lengthens according to the weights of the different bodies suspended from it. The weight is shewn on a graduated circle, to which an index points. I beg leave to submit it to the Society for its approbation. I am, Sir,

Your humble and obedient Servant, WILLIAM MARTIN.

No. 75, High Street, Mary-le-bone, Dec. 6th 1813.

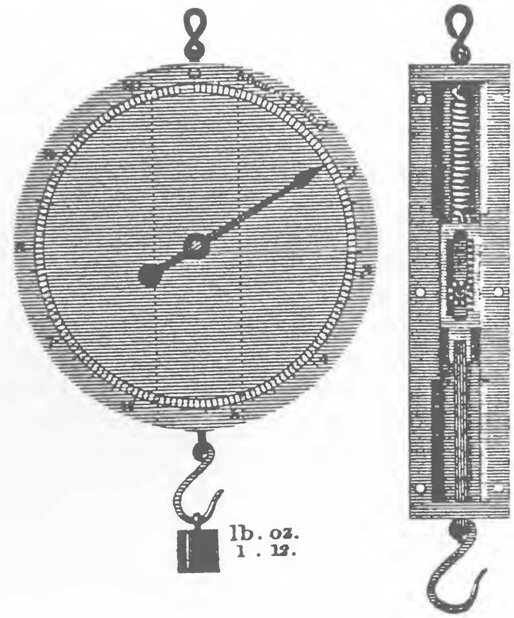


Fig. 6. William Martin's Weighing Machine, from the Journal of the Society of Arts, vol. XXXII, 1814. ➢➢

From the editor
Please would members write to the editor if they can add to the evidence compiled, or answer any of these interesting questions. Members will recollect that dial-faced balances without a slide were approved by the Académie Royale des Sciences in France in 1788 (see EQM, page 1866.)

Showcase

Vernon Denford has a coin-scale by Richard Wood. The mahogany MUB is lined with green baize, and has two square pens. Ten or eleven weights were needed in Britain when the label was designed for John Wood, his father. Thomas Goulding succeeded his master John Wood, (as Richard was not yet fully trained) and was succeeded by Richard Wood, who worked at 15 Cheapside from 1780 until his retirement in 1817, but he only died in 1836. Note that the reference to "*Late Goulding*" has been erased from the plate, so one assumes that this was his second label, but he left the out-dated coin list for coins that were seldom seen once new guineas were minted in 1774. As Thos Goulding had the shop for 25 years, Richard Wood had a separate shop at Noble Street until Goulding left. Richard Wood trained his nephew and successor, Robert Wood, who, when in partnership with Henry Wood, working at 6 & 7 West Smithfield, was taken over by Thos Herbert & Sons in 1869. (See EQM p 1723-48.) Coin-scales are known by John Wood, Thomas Goulding and Richard Wood.

Basic Library for Americans, Part 2

Expansion of the Paper presented at the New Orleans Convention, 30 May, 1996

By R H WILLARD

This paper is published primarily to assist ISASC members in finding reliable information about the technology of weighing, its instruments and its pioneers. These suggestions will lead them to publications that can help them understand and enjoy their acquisitions and place them in their historical settings.

The Library System (continued from the last EQM)

Because so much metrological information comes from out-of-print sources, the use of photocopies is extremely helpful. However, the laws pertaining to copyrighted material must be observed. Complete works bearing the copyright notice may not be duplicated or distributed without permission from the author or copyright-holder; however, Section 107 of the Copyright Act permits "fair use" of excerpts. Students and researchers customarily make photocopies of the portions needed for their personal use in current projects. Many uncopyrighted works published before 1900 and all the U.S. Government publications are in the public domain, and can be used without restriction.

The examples listed below are for general, basic information. Each book or essay will have its own bibliography listing specialised sources. Always photocopy these citations; they will guide you to the best metrological scholarship in your areas of interest. For lack of space, we did not include journal articles which are in the ISASC Index (forth-coming).

Reference Department (non-circulating works)

Bibliography of Weighing Instruments, edited by Eric and Judy Soslau. ISASC, 1995. Mentioned here to encourage ISASC members to get their local reference library to stock this unique list. Emphasise that this is the only publication specialising in the **instruments**, as opposed to all the bibliographies covering weights and measures. Incorporates the research and expertise of ISASC members.

Biographic Index of American Science, the Seventeenth through the Nineteenth Centuries, by Clark A Elliott. Westport CT and London, England: Greenwood Press, 1979. Learn about the internationally-renowned scientists and inventors who shaped American metrology and its artefacts. If you are interested in non-Western metrology, ask about the forthcoming

Encyclopaedia of the History of Science, Technology and Medicine in Non-Western Cultures, which will be released in Autumn 1996 by Luwer Academic publishers of The Netherlands.

encyclopaedias of the history of technology for articles about weighing, weighing machines, weights and measures, etc. Also check those topics for any other countries of interest to you.

general encyclopaedias (especially any older editions).

Handbuch der Historischen Metrologie Band I, by Harald Witthöft. St Katherinen, 1991. 377 pages of lists of metrological books, under country or state headings. Very weak on English- and French-language books, but brilliant for German material.

Photocopy the essays you like best. For future reference, be sure to include the title page and copyright date of the work as well as the bibliography following each essay. Set up a filing system you can live with. Index your holdings.

The Stacks (circulating works) Good basic books

Most libraries will have several of these books. Be sure to look at any additional titles shelved nearby. A reference librarian can help you locate elusive titles through the interlibrary loan service. Photocopy

the pages of special interest to yourself, (including the introduction, index, and bibliography). Look for a copy service with a curved copy board, which spreads the book to print the entire page without injuring the spine. Examples:

Scales and Weights, general

[For special types - money, gold, postal, grain, etc., see the ISASC Bibliography and the EQM Index.]

Brauer, E, *The Construction of the Balance*. English translation by N C Walters. London, Incorporated Society of Inspectors of Weights and Measures, 1909. German editions 1880, 1887, 1906. Includes theory, numerous diagrams (mainly of industrial machines) and lots of drawings of small scales made by makers all over Europe in the third quarter of the 19th century.

Chisholm, H W, *On the Science of Weighing and Measuring and Standards of Measures and Weights*. London, Macmillan & Co, 1877. Particularly lucid explanations, suitable for the non-expert.

Halsey and Dale. *The Metric Fallacy*. New York, 1904. The opinions of American engineers and manufacturers on the metric system. Read today, a very funny book on prejudices.

Kisch, Bruno, *Scales and Weights, A Historical Outline*. New Haven and London, Yale University Press, 1965, 1966. The most important general reference book for anyone interested in weighing and its artefacts world-wide and throughout history. Extensive multilingual bibliography.

Owen, George A, *Weighing Machines: A Guide to the Principles Underlying the Construction of Weighing Instruments*. London, Charles Griffin & Co Ltd, 1922. A clear explanation of the basic technology of weighing instruments with illustrations of early 20th century trade scales.

Rush, Philip and John O'Keefe, *Weights and Measures Methuen's Outlines*. London, W & J Mackay & Co Ltd, 1962, 1966. Written for schools. Some errors, but a neat résumé. Includes scales.

Skinner, F G. *Weights and Measures: their ancient origins and the development in Great Britain up to AD 1855. A Science Museum Survey*. London, Her Majesty's Stationery Office, 1967. An excellent complement to Crawforth and Kisch.

Stock, John T. *Development of the Chemical Balance, A Science Museum Survey*. London: Her Majesty's Stationery Office, 1969. Excellent photographs. If unable to read the books and journal contributions by Jenemann in German, this is the best available on chemical balances.

Publications of Professional Scale Makers

Avery W & T Ltd, *Glossary of Terms used in the Scale Trade*. Birmingham, England, 1912.

Catalogues, illustrated price lists and technical leaflets of scale-makers and distributors.

Cochran, Robert. *Patent Balance Compared with Other Instruments for Weighing*. Presented by the author to the Presidents and Members of the Select and Common Councils of the City of Philadelphia, February 24, 1803.

Considine, Douglas Maxwell. *Industrial Weighing*. Modern Library of Civil Engineering. New York: Reinhold Pub. Corp., 1948. See Fig. 2.

Detecto. *A Pictorial History of Scales*. 50th anniversary diary, with 52 archival drawings collected from many countries. New York, 1950.

Gurley, W & L E. *Gurley's Handbook of Weights and Measures for the Use of Sealers*. 4th ed. New York, 1912.

Lynn, William A. *Scale Mechanics' Handbook*. National Scale Men's Association, n.d. The plainest, most straight-forward explanations of the basic principles of weighing, with clearly-expressed descriptions of how to correct errors. Extremely useful. See Fig. 1.

Mettler Instruments A.G.. *Dictionary of Weighing Terms*, 1983.

Mettler. *Mettler News 1-22*. The first 22 issues, 1956-1961, bound into 1 volume.

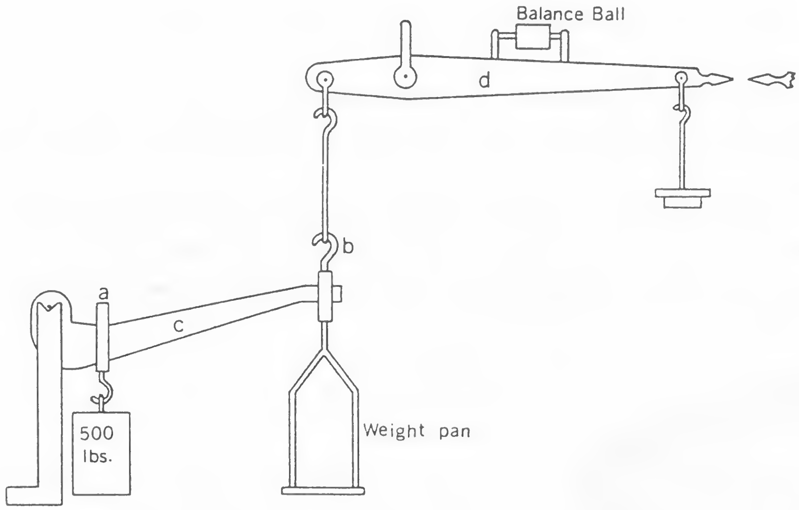


Fig. 1. One of the plain drawings from the *Scale Mechanics' Handbook* by Lynn. Many companies are discussed separately, when their mechanisms are peculiar to themselves only.

Any collector who repairs his own scales would be well-advised to obtain this excellent book.

National Scale Men's Association. *Scalemen's Handbook of Metrology*. Napierville IL, NSMA, ongoing to approximately 1980.

National Scale Men's Association. *Glossary*. Chicago: Streeter-Amet Company, 1936.

O'Keefe, John A. *The Law of Weights and Measures*. London, Butterworths, 1966.

Roberts, J. *Handbook of Weights and Measures*. London, 1906.

Scale Manufacturers' Association, Washington, D.C., Terminology Committee. *Terms and Definitions for the Weighing Industry*. Washington D.C. 4th edition, 1981. [Previously published as *Terms and Definitions for Load-Cell and Electronic Weighing*, in 1955, 1958, 1964 and 1975.]

Scheurer, W A, President of the Exact Weight Scale Co. *The Science of Weighing Yesterday*. Published for the 50th National Conference on Weights and Measures held Washington D.C. in 1965 and also in Scale Journal, vol. 57, No. 5: 10-17: No. 6: 4-8; No. 7: 12-14, 1973.

Troemner Inc. *Mass Standards Handbook*. Philadelphia PA, 1990.

Weight standards, world-wide, throughout history

Berriman, A E. *Historical Metrology: A new analysis of the archaeological and the historical evidence relating to weights and measures*. USA: E P Dutton & Co., 1953; rept. New York, Greenwood Press, 1969. Predominantly on the Western Civilisations from Sumer to Minoa, with a very brief résumé of the period after Christ.

Nicholson, Edward. *Men and Measures: A history of Weights and Measures Ancient and Modern*. London: Smith Elder & Co., 1912. Written from a British perspective, with some delightfully acerbic comments on some peculiar local aberrations.

Perry, John. *The Story of Standards*. USA: Funk & Wagnalls, 1955. Especially useful to American collectors since most such books are European.

Ridgeway, William. *The Origin of Metallic Currency and Weight Standards*. Cambridge 1892; rept. New York: Attic Books Ltd, 1976.

Cambists (monies, weights, & measures of the nations trading with Europe at a given time)

Arbuthnot, Charles. *Tables of Ancient Coins, Weights and Measures Explained and Exemplified*. London: J. Tomson in the Strand, 1727.

Easton, H T. *Tate's Modern Cambist: A manual of Foreign Exchanges and Bullion with the Monetary Systems of the World and Foreign Weights and Measures*. London: Effingham Wilson, 1908.

Kelly P, *The Universal Cambist and Commercial Instructor, being a full and accurate treatise on the Exchanges, Monies, Weights, and Measures of all trading nations and their colonies; and account of their banks, public funds, and paper currencies*. London, 1821.

Spalding, William F. *Tate's Modern Cambist, Centenary Edition.* London: Sir Isaac Pitman and Sons Ltd, 1929.

Tate, William. *Cambist, an account of world currencies, foreign exchanges, and weights and measures*. Published in 1829 and every 4 years thereafter (with various authors) for at least 100 years. Any edition will be useful.

Woolhouse, W S B. *The Measures, Weights and Monies of All Nations.* London, John Weals, 1859. Over 80% of the book is conversion tables, with a brief text on standards and British coinage.

Make your own Cambist by photocopying tables of weights from a large dictionary. Bind them and keep them near you for quick referral.

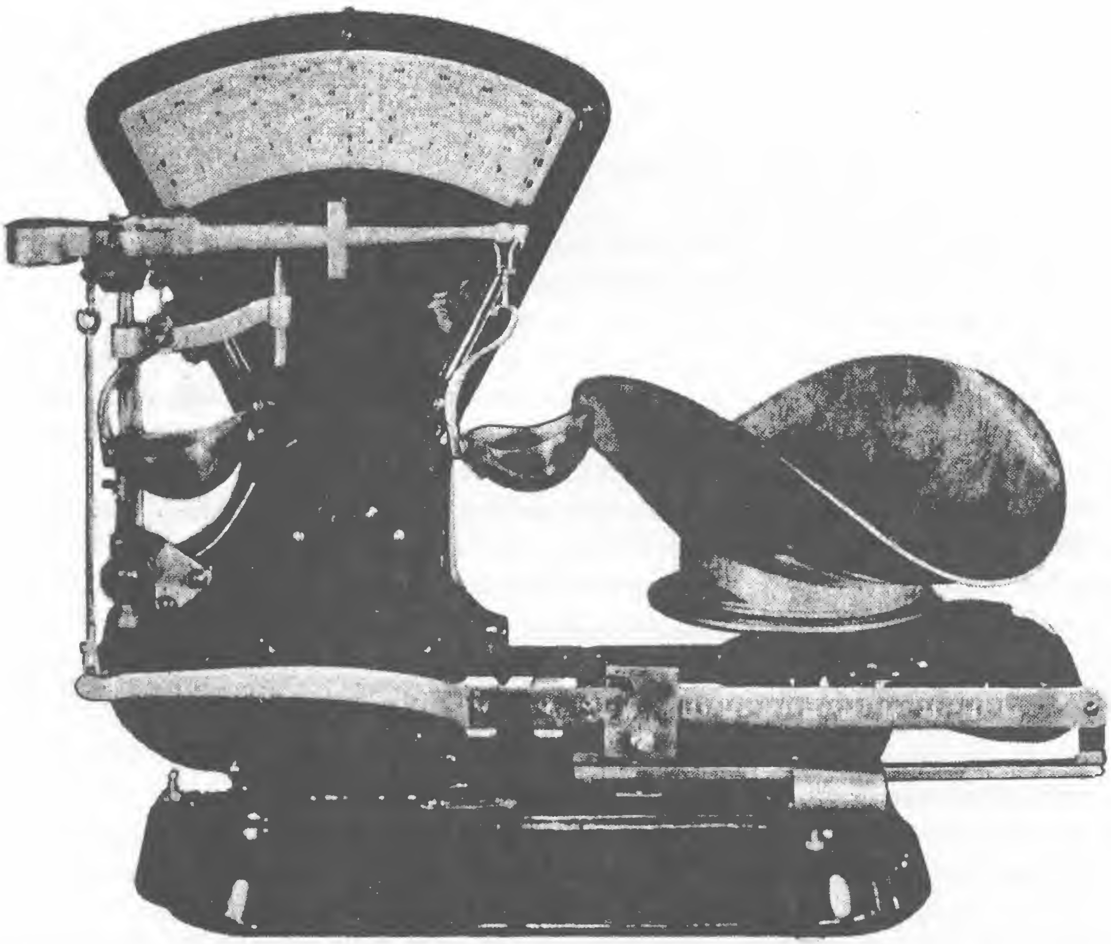


Fig. 2. A Combination Double-ratio Counting and Weighing Scale, illustrated in *Industrial Weighing* by Considine. This is but one of a large range of counting machines that could form a complete collection on their own. The range and style of counting machines is fascinating and deserves to be studied.

Periodicals

Academic and professional journals as well as trade magazines and microform files of major newspapers (sometimes indexed) can be found here. If you do not find the journals you are looking for, ask a librarian to help you request copies of the material through interlibrary loan. Try both public and educational libraries; they often have access to different sources. Examples:

Davison, C St C "Landmarks in the History of Weighing and Measuring", *Newcomen Society Transactions* 31: 131-152, 1961.

Eaches, Albert R. "Scales and Weighing Devices: an aid to identification. Technical Leaflet 59". *History News* Vol. 27 No 3, March 1972. Reprints may still be available from the Association for State and Local History, 1400 Eighth Ave. South, Nashville TN.

Frazier, Arthur H, "United States Standards of Weights and Measures: Their Creation and Creators". *Smithsonian Studies in History and Technology* No 28, 30 December 1974. Out of print.

Harkness, William. "The Progress of Science as exemplified in the art of weighing and measuring". Presidential address, *Bulletin of the Philosophical Society of Washington*, 10: 39-86, 1888.

Hocker, Fred, Sarah W Yamini and George O Yamini. "The Scales and Weights from Serce Limani". *The Institute of Nautical Archaeology Quarterly*, Vol. 20, No 3. Significant metrological findings aboard an 11th Century Byzantine shipwreck excavated 1977-1979.

"Making Scales", *Progress of the World - Inventions, Engineering, Science, Industrial Developments*. Vol. 7, 1915. (See EQM 333-348, 447-452).

Moore, Dr. Samuel, Director of the U.S. Mint. Report "How The Mint acquired the Pound Troy standardised by Captain Kater". *Journal of the Franklin Institute*, New Series, vol. 13, April 1834: 302-304.

Sanders, L. "Evolution of the Pivot, with special reference to Weighing Instruments". *Transactions of the Newcomen Society*, vol. XXIV, 1944, 81-91.

"The US Assay Office at New York", *Harpers Weekly*, 14 Jan 1882. (See EQM 531-534).

Government Documents Examples

Adams, John Quincy. *Report upon Weights and Measures. Prepared in Obedience to a Resolution of the Senate of the Third March, 1817*. Washington, 1821.

Anon. *Report of the Secretary of the Treasury on the Construction and Distribution of Weights and Measures*. Washington, A O P Nicholson, Printer, 1857. Executive Document.

Bache, Alexander. *Report to the Treasury Department on the Progress of the Work of Construction Standards of Weights and Measures and Balances in the Years 1846 and 1847*. Executive Document 73: 1-29, 30th Congress, 1st Sess. 1848.

Hassler, F R. *Instructions Relating to the Use of Standard Weights*. House Document 545, 25th Congress, 2nd Sess., 1839.

Joint Resolution of Congress No. 46, March 2, 1843, requesting the President (if in his opinion it be expedient) to cause to be presented to Great Britain a set of U.S. Standard weights and Measures to replace those which are understood to have been destroyed in London by accidental fire. Copy in the National Archives.

Judson, Lewis V. *Units and Systems of Weights and Measures*. National Bureau of Standards Circular 570, Washington D.C., 1956.

Lashof, T W and McCurdy L B. *Precision Standards of Mass and Laboratory Weights*. NBS Circular 547, Washington D.C., 1954.

Warnlof, Otto K. *Examination Procedure Outlines for Commercial Weighing and Measuring Devices: A Manual for Weights and Measures Officials*, NBS Handbook 112. Washington D.C.: U.S. Dept. of Commerce, National Bureau of Standards, 1973.

Treasures to Look at: Rare Books and Special Collections

Most libraries hold a number of very old and rare books and documents. While usually displayed under glass, these frequently may be examined under supervision. You may be asked to show identification, check your brief case or handbag, and bring only a pencil and tablet (no pens, binders or portfolios) to the table. These fragile works may not be photocopied, but portions sometimes may be photographed, and notes can be taken. An unforgettable experience! Examples:

Agricola, Georg. *Libri quinque de Mensuris et Ponderibus.* Basel, 1533. Well illustrated.

Agricola, Georg. *De Re Metallica.* 1556. Schematic drawings to explain whole industries.

Alembert and Diderot. *L'Encyclopédie, ou Dictionaire Raisonné des Sciences, des Arts et des Métiers.* Geneva: 1751 on. (See EQM 468-476). So many pictures of craftsmen using scales to pursue their trades. A reprint available; 485 plates selected from the Encyclopédie as *A Diderot Pictorial Encyclopedia of Trades and Industry*, with explanatory notes by C C Gillispie. Dover Publications Inc. New York, 1959 and 1987.

Chambers, E. *Cyclopaedia, or an Universal Dictionary of Arts and Sciences.* London, 1728. Good illustrations.

Harris, John. *Lexicon Technicum or an Universal English Dictionary of Arts and Sciences.* London, 1723. Well illustrated.

Jaubert, Abee. *Dictionnaire Raisonné Universel des Arts et Métiers.* Paris: 1st edition, 1764.

Leopold, Jacob. *Theatri Statici Universalis Pars I, sive Theatrum Staticum, das ist Schau-Platz der Gewicht-Kunst und Waagen, Pars II, oder Schau-Platz der Wissenschafft und Instrumenten zum Wasser-waagen, Pars III sive Theatrum Aerostaticum, oder Schau-Platz der Machinen zu Abwiegung und Observirung aller vornehmsten Eigenschafften der Lufft, Pars IV sive Theatrum Horizontostaticum sive Libellationis oder Schau-Platz von Wasser- oder Horizontal-waagen.* Leipzig, 1726. Wonderful drawings of scales of the period. Fascinating to study. Language not a problem, as the drawings say it all! Reprints have been produced in limited editions.

Lunier, M R. *Dictionnaire de sciences et des arts.* Paris: 1806.

Some internet sources

The home page of the Society for the History of Technology leads to links to myriad academic institutions, museums, libraries, publications. etc. (http://hfm.umd.umich.edu/tc/SHOT). The World Wide Web Virtual Library (http://www.w3.org/hypertext/DataSources/by Subject) offers innumerable links in History of Science, Technology and Medicine; see also the Lemelson Center for the Study of Invention and Innovation (http://www.si.edu/organiza museums/nmah homepage/lemel/start.htm). The Library of Congress Home Page (http://lcweb.loc.gov/) includes "research and Collection Services" and "Library of Congress Online Services"> Both Excite (*http://www.exite.com/search.gw*) and Yahoo include numerous listings for the Library of Congress. For extensive information of Ohaus scales, see Lycon (Science and Technology - Scientific and Medical Antiques - Sales).

Ideas for Original Research

The Patent and Trademark Office, Washington D. C., 20231 (or on the Internet www.uspto.gov.) can supply a list of the 80 branch depositories in the US where patrons may search for patents. If the date of a patent is known, it can be located by checking all the patents issued on that day. There is an alphabetical index by patentee for the years 1870-1971, and an electronic index thereafter. US patent records describe and usually illustrate each invention, give the name and place of residence of the patentee and name any assignees. Hard copies can be purchased.

Federal census records (1850 and later), state and county histories with their bibliographical dictionaries, city directories, historic telephone books, and correspondence with state and local public, business, historical, and genealogical libraries can supply additional details about the patentee, his family, his manufacturers, and his distributors.

Finally, the *ISASC membership List:* Have you checked the list for dealer-members who may offer old books for sale?

The Mysterious Hoadley Scale

By G A WEHMAN

Who made the Hoadley scale, and what was it used for? These questions have stimulated some lively speculation among ISASC members, over the years, and now, at last, by putting all our findings together, we come up with at least some of the answers.

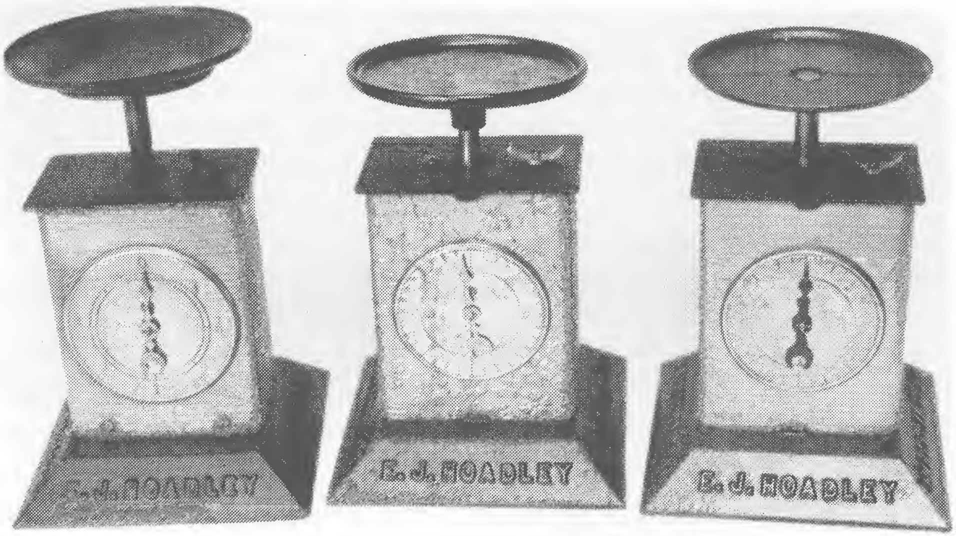


Fig. 1. The three scales made for E J Hoadley, with the herringbone-textured ones each side of the floralllly-decorated one.

Photo P Wehman

Looking at the scales themselves, we have three scales of the highest quality, very crisply manufactured of heavy-duty metals, made to work efficiently over a long period. The manufacturing method and quality is unique. We don't think that this maker worked on any other scales that we have handled.

We find a basic model, a half-roberval and spring scale with a rack and pinion mechanism and a dial face indicating a capacity of 2 pounds. The cast iron base is 4½ ins square at the bottom, bevelled

Fig. 2. The scale on the left is not held together by a long bolt, (the top of which bolt can be seen just to the left of the central rod on the middle and right-hand scales.) The two screw-heads below the dial go through the panel and into iron lugs coming up from the base, thus attaching the body to the base. There are also two screws at the rear.

Photo P Wehman

to 3 inches square at the top, with the name E J HOADLEY in raised letters on the front and back bevels and HARTFORD CONN. on each side. The rectangular body of the scale is of sheet brass with an embossed pattern all over it.

Fig. 3. Goods-pan holder with patents.

Unlike most spring scales, it is mounted on the base with the longer side parallel to the front of the scale. This provides a surface for mounting a larger dial protected within the body panel. The dials are of stamped brass, nickel plated, and roughly 2¼ inches in diameter. Each scale has a metal goods-pan holder, and two have a distinctive oval scoop of hammered brass, roughly 7 inches by 9 inches in size and shaped to fit into the goods-pan holders showing in Fig. 1. A wing-nut on top of the body acts as a tare-screw, to adjust the pointer to zero, both with the scoops *and without*. This range of adjustment makes it possible to argue that the designer foresaw the scale being used as both a candy scale and a postal scale. As shown in Fig. 2, adding the scoops without adjusting the tare moves the pointers round the dial. The two scoops are of different mass, the left hand one weighing 4 oz. and the right hand one weighing 5 oz. Thus the tare had to cover a very large range of adjustment.

The three scales illustrate the variations known to us. The measurements of the three scales vary by about $^{1}/_{16}$ inch. The earliest model is the one on the left in figures 1 & 2. The goods-pan holder (Fig. 3) is of cast brass, concave in shape, with six patent dates embossed in the centre: Aug. 14, 88; Aug. 20, 90; Sep. 9, 90; June 17, 90; June 16, 91; and Jan. 5, 92. The body has an embossed herringbone design all over it, and is attached to the base with two screws on the front and back. The dial is marked to weigh 2 pounds by ¼ pound. The scoop might be a replacement, since it does not fit perfectly into the goods-pan holder, but the hammer-blows are identical on both scoops, arguing for their being original.

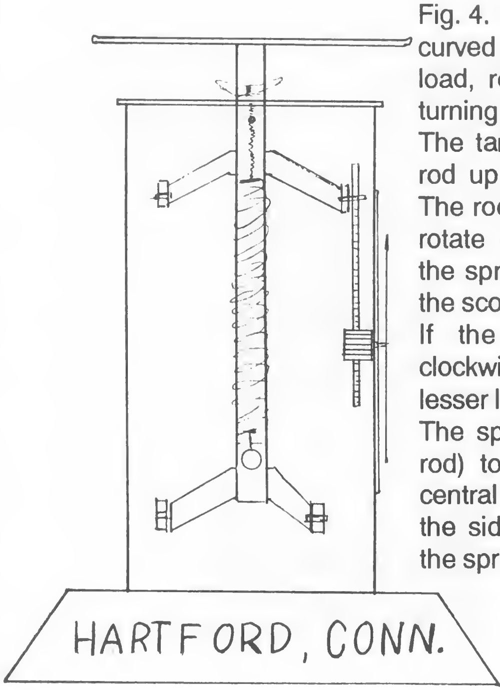
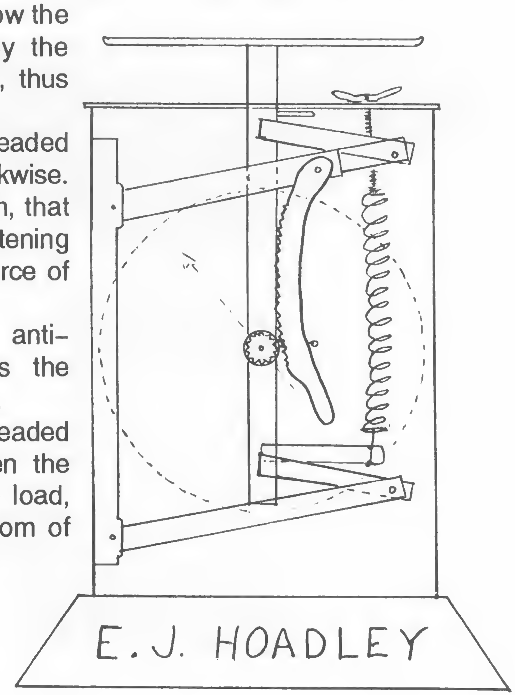


Fig. 4. The later design, showing how the curved ratchet is pushed down by the load, rolling the central cog round, thus turning the pointer.
The taring screw pulls the little threaded rod up if the screw is turned clockwise. The rod has two wings at its bottom, that rotate down the spring, thus shortening the spring and counteracting the force of the scoop.
If the taring screw is turned anti-clockwise, the spring counteracts the lesser load of the goods-pan holder.
The spring is attached (by the threaded rod) to the top of the case. When the central rod is pushed down by the load, the side-arm, attached to the bottom of the spring forces the spring to open.



Probably the next oldest scale is shown on the right in figures 1 and 2. Like its predecessor, it has the herringbone design embossed on the body. But the goods-pan holder, of nickel-plated pressed steel, is perfectly flat with a rim into which the oval scoop fits perfectly. It has a tubular sleeve riveted neatly under the centre, to slip over the vertical rod attached to the half-roberval linkage. The body is attached to the base by a long bolt that runs from the top of the body through the base, with a wing-nut under the base, and held in position by a set of lugs raised from the cast-iron base. The dial is calibrated to weigh 2 pounds by 1 ounce. There are no patent dates in the goods-pan holder, so the patents had expired.

Table 1. Hartford, Conn. city directory entries for Edward J Hoadley

Dates	Trade	Work address	Home address
1875–1876	confectioner	160 Asylum	
1876–1878	cigars & confectioner	143 Main	113 Pearl
1879	cigars	18 Pratt	113 Pearl
1880–1883	cigars	236 Asylum	6 Trumbull
1884	confectioner	284 Asylum	6 Trumbull
1885–1893	confectioner	452 and 454 Asylum	16 Garden
1894	manufacturing confectioner	19 Foot Guard Place	16 Garden
1895–1900	confectioner	19 Foot Guard Place	
1901–1912	confectioner	19 Hoadley Place	
1913–1919	Hoadley Manufacturing Company	19 Hoadley Place	
1920			16 Garden

Functionally, the scale shown in the centre of figures 1 & 2 is identical to the others. The only difference lies in the brass panels of the body, which are embossed with a pattern of wild flowers and leaves on their stems. The floral design reflects perfectly the art-nouveau period of the late 1890s and early 1900s. The goods-pan holder shown on this scale, of cast iron, might be a replacement, but as it was so professionally manufactured, this seems a remote possibility.

Because of their relatively small size and the fact that many of the Hoadley scales in private collections have only the flat goods-pan holder without the scoop, there has been speculation that they were only postal scales, probably for household use. But finding the early model with its concave goods-pan holder and its dial marked to weigh in ¼ pound increments convinced us that these were candy scales.

Next, we began wondering about Hoadley himself. Was he a scale maker, or was he a confectioner who bought the scales with his name on them and used them as goodwill give-aways, as Grove Co. did? (See Old Advert.) According to the Geer city directories of Hartford, Conn., E J Hoadley was a confectioner and cigar dealer from 1875 to 1912 at various addresses, see Table 1. (Since the street number in the final entries did not change, it would be interesting to learn whether he actually moved, or whether the street was renamed in his honour.) From 1913 to 1919 his firm was listed as Hoadley Manufacturing Company, still at 19 Hoadley Place. He must then have retired, because in 1920 he was listed simply at his home, 16 Garden.

What kind of confections did E J Hoadley manufacture? Dennis Thompson of North Olmstead, Ohio (a descendant of the Hoadley family) states that E J Hoadley produced **Moses' Cough Drops**. Probably, like other confectioners, he used the scales as an enticement to induce his customers to buy in large quantities. Recalling that the Hoadley scale was patented in 1888 to 1892, we suspect that the free scales, along with what was undoubtedly an excellent product, probably contributed to the fact that by 1894 his annual output of cough drops was 200 tons, which were being sold in more than 1300 retail establishments in the U.S. and Canada.

But we still don't know who made the Hoadley scales! Although the patent dates are known, we have not yet been able to identify these six patents from the microfiche records at our nearest Patent and Trademark Depository. Can any reader help?

References

Hadley, J, Business, Science and Technology Dept., Hartford Public Library, letter of 5th July 1988 to Jerome Katz.

Stein, Bob, ISASC President's Newsletters, April 1994 and July 1995.

Circular, The Grove Co., Salem, Ohio, offering a tea, confectionery and tobacco scale made by Jones of Binghampton to purchasers of ten boxes of Grove's Peerless Assortment Chewing Gum. See below.

Thanks to Gary Basch, Jerome Katz, Bob Stein, Dennis Thompson and Lewis Weiss who contributed to this article.

Author's biography

George Anna Wehman's collection is eclectic, including family, counter, candlestick, coin-operated, postal and desk-set scales and ranging in size from a 2 ins toy spring scale to a truck scale (at present disassembled) formerly used by her father to weigh cotton, corn and hay on the family farm. She is especially fond of advertising scales. She also collects measuring sticks with the merchants' names on them.

While her husband, Phil modestly disclaims any part in George Anna's collecting, she describes him as her negotiator, mechanic, polisher, artist and photographer in residence. Together they presented an excellent demonstration on scale photography at the 1992 ISASC convention in San Diego. Phil took the excellent photographs and did the drawings appearing in this article, and in EQM from time to time.

GROVE'S PEERLESS

TEA,

CONFECTIONERY,

TOBACCO,

SCALE.

1-2 OZ. TO 4 LBS. PRICE, $8.00.

WARRANTED BY

JONES OF BINGHAMTON.

TO THE PURCHASER OF TEN (10) BOXES

GROVE'S

PEERLESS ASSORTMENT

CHEWING GUM.

Old Advert

This offer of an $8.00 scale if $6.00's worth of chewing gum was purchased, makes us wonder how long the Grove Co. stayed in business. How many merchants took up the offer?

From G A Wehman

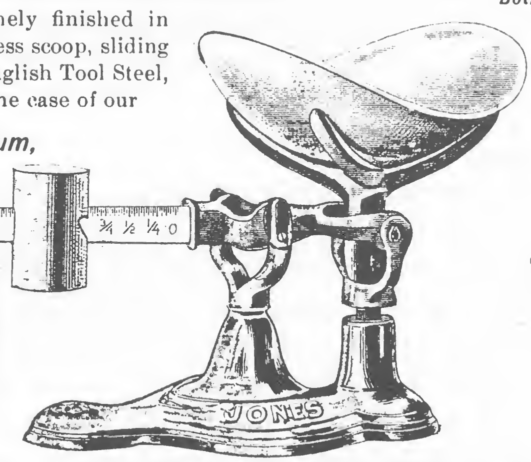
THE GROVE CO., Salem, Ohio.

Give free one Peerless Scale, handsomely finished in Vermillion and Gold, with brass seamless scoop, sliding poise beam, no weights, pivots of best English Tool Steel, carefully hardened, to the purchaser of one case of our

Peerless Assortment Chewing Gum,

AS FOLLOWS:

Both Chewing Gum and Scale are packed in one case.



2 box	40-5c. pack'g's	Jersey Fruit,	foil	wrap'd	$2.00
1 "	20-5c. "	Pepsin	"	"	1.00
3 "	300 sticks	Pepsin	paper	"	3.00
1 "	100 "	Blood Orange	"	"	1.00
1 "	100 "	Banana	"	"	1.00
1 "	100 "	Pineapple	"	"	1.00
1 "	100 "	Tuxpan, Mint flvr.		"	1.00
		Retail Value,	.	.	$10.00
		1 Peerless Scale,	.	.	8.00
		Total Retail Value.		.	$18.00

Order of your Jobber at once as this offer is only good for a short time.

COSTS THE RETAILER $6.00 PER CASE. The Scale alone is worth more than the amount invested.

Our Chewing Gums guaranteed equal to any on the market and the retailer will find "PEERLESS ASSORTMENT" a fast seller.

U.S. Candy Scales

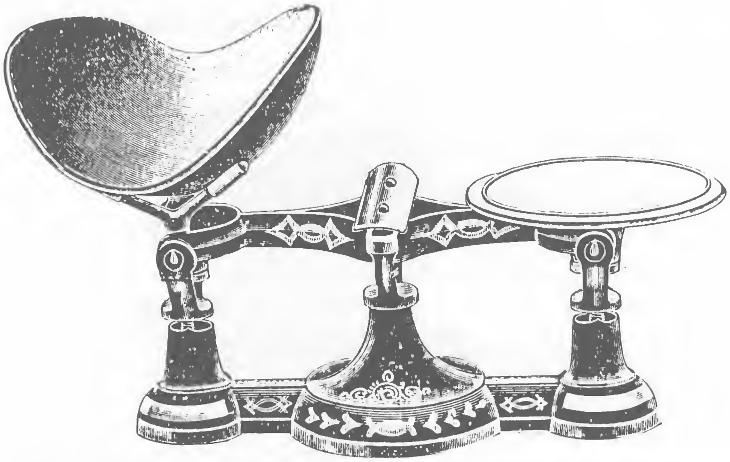


Fig. 1. AA John Chattillon & Sons 1894 Candy Scales with brass scoops nickel-plated, finished in black and gold handsomely ornamented. Capacity 2 lbs, 4 lbs or 8 lbs, at $10.00, $13.50 or $17.00 each.

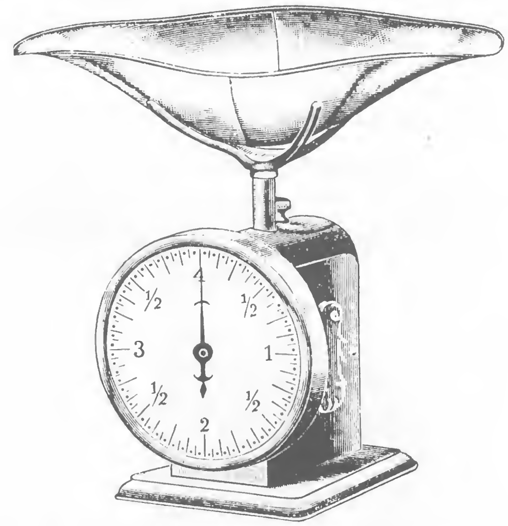


Fig. 2. AA Norvell-Shapleigh Hardware Co, 1903 catalogue. Pelouze *'perfect candy, tea, spice and tobacco scale'*. Capacity 4 lbs by ½ oz. Nickel-plated $4.00. Same period as the Hoadley scales. From T Stein

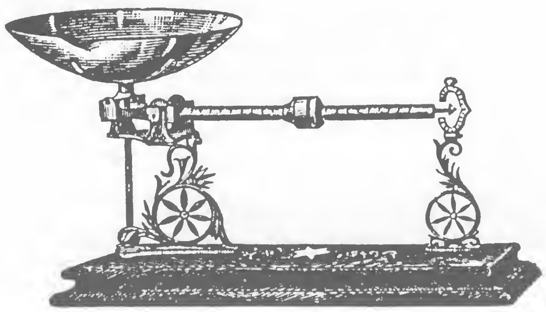


Fig. 3. AA Henry Troemner 1899 catalogue. *'Specially made for retail druggists for weighing out candy, cough drops etc. No weights.'* Capacity 1 lbs. Price $8.00

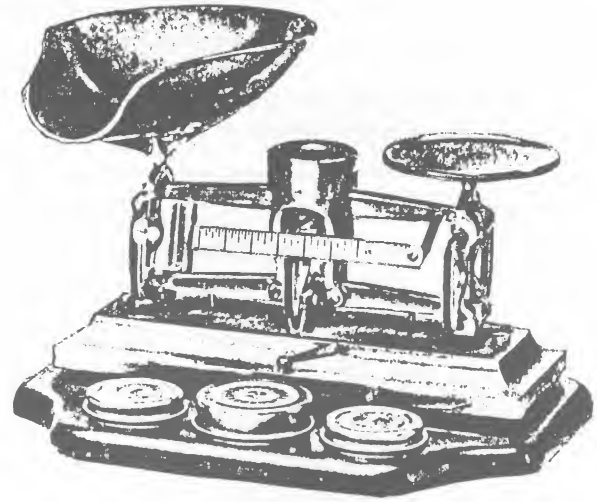


Fig. 4. AA Torsion Balance Co, 1915. *Capacity 5 lbs, sensitive to 3 grains*! Beam 9 ins long. Side beam graduated by ¼ oz to 16 oz. Base oak, mahogany or glass. The most expensive at $30.00.

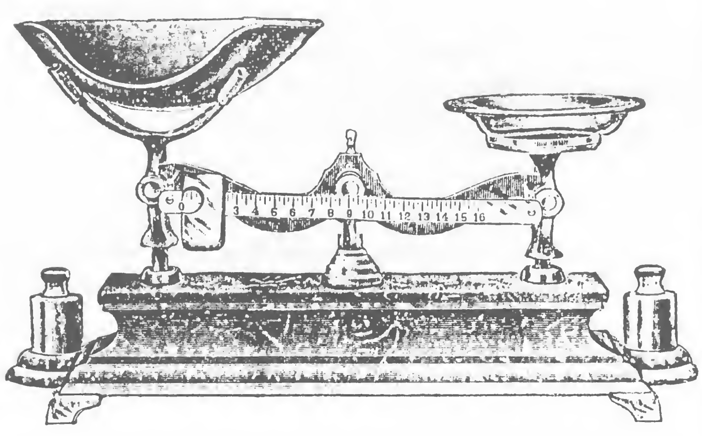
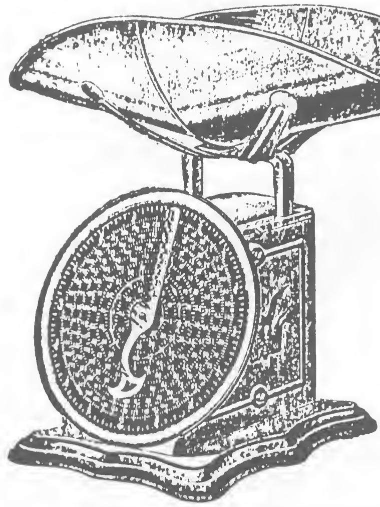


Fig 5. << John Chatillon & Sons 1894 Candy Scales. Base marble, granite or oak. Capacity 3 lbs. This expensive $25.00 balance was also supplied by Henry Troemner, but seems not to fit with the manufacturing methods of either company. Can any ISASC member identify the maker?

The Triner catalogue of 1910 shows the cheapest candy scales, only 10% of the cost of the most expensive candy scales, but still suitable for trade use. Triner mention all the positive points, but quietly ignore the exposed springs in many of them! Fig. 8 shows a candy scale that definitely was also a postal scale. The Hoadley scales could similarly have been intended as dual-purpose scales.



Capacity, 4 pounds, by ½ ounces.

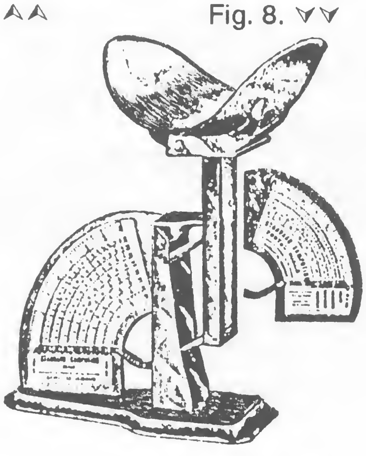
The New Champion Computing Scales have a 6-inch brass dial with figures and marks raised from the solid metal, very distinct and indestructible. They compute the cost of merchandise from 10 cents to 60 cents per pound, and also show weight by ½ ounces up to 4 pounds.

No. B-2. Champion, body gold bronze. Large brass scoop, highly polished.
List price....................................each, **$4.75**

No. C-3. Champion, body green enameled, transferred in gold and striped in gold. Large brass scoop, highly polished. List price........ ....each, **$3.75**

No. D-4. Champion, body black enameled, transferred in gold and striped in aluminum and red, with large polished brass scoop. List price.............each, **$3.25**

Fig. 6. ▲▲ Fig. 8. ▼▼



Capacity, 2 pounds, by ½ ounces.

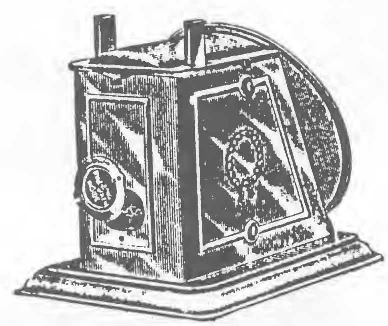
The **"Standard Double Dial Computing"** Scale is an ornament to any counter. Occupies less space than any other scale.

On the side facing salesman, it computes the cost of any merchandise weighed from 10c to 60c per lb., and on the other side, facing customer, shows postage on all classes of mail matter to all parts of the United States, Canada, Mexico, Cuba, etc.

Body is magnificently nickel plated. Furnished with a large brass scoop, heavily nickel plated.

List price, - - - - - - each, **$3.25**

Rear View Showing Regulating Screw



The above illustration shows our **Patented Regulating Screw** which complies with the regulations of city sealers, as it is located inside of frame and is sealed with a lid, which prevents anyone from tampering with it after the scale is set at the starting point.

This regulating device is so arranged that you can easily adjust it for a scoop, basket or any other vessel, and it has a self-locking device inside of the frame which keeps the index at the starting point after being set and prevents it from being jarred or shaken out of position, an advantage not possessed by any other automatic scale.

Fig. 7. ▲▲ Fig. 9. ▼▼

Our Confectionery Scales are built light enough to be used on the Showcase or Counter, and are very ornamental.

They excel all others, in having the dials extended on some, so that they are in clear view when using the scale to its full capacity; while the round dials on the other scales, are placed at a proper angle, so that they are squarely before the eyes and can be read at a glance without stooping.

The **Interior Mechanism,** as well as the frame, is made of the best cold rolled steel, making them light and strong.

Each Scale is provided with a regulating screw inside of the frame at the rear end of the Scale where it cannot be tampered with.

The **Platform** is supported on Double Steel Uprights, which distributes weight and insures accuracy.

The **Dials** on all the scales are very distinct, easily read and indestructible in cleaning.

The **Computing Dials** compute without any mental calculation, but with a positive, accurate, mechanical device which indicates correct weight, and shows the cost in dollars and cents of all articles weighed.

They are superior to all other makes in Quality, Workmanship and Finish.

Always in order and ready for instant use.

Each Scale boxed separately and guaranteed.

Review

The Weights and Measures Act 1878 to 1904 by J Devonald Fletcher, published by Sherratt & Hughes, 1908. Out of print.

This book reminds us that we must not get so absorbed in the methods and instruments of weighing that we forget their aim - accurate and uniform measurement of mass for the general benefit of society. The emphasis on certain commodities and how they were sold also reminds us of how society has changed.

The opening pages deal with past problems of locally accepted weights by emphasising that the same weights and measures should be used throughout the United Kingdom. Unfortunately the desire for uniformity ruled out such pleasant customs as that of one particular market where every "pound" of butter contained eighteen ounces.

The Acts also anticipated new problems caused by developments in science and technology, stating that "*the Board of Trade shall from time to time cause such new denominations of standards for the measurement of electricity, temperature, pressure, or gravities as appear to them to be required*".

The denominations of Board of Trade Standards of Imperial weights and measures reminded me forcefully of the tables that used to be found on the backs of exercise books, and for once, I appreciated metric weights and measures. Incidentally, the Acts made provision for Queen Victoria by Order in Council to make a table of metric equivalents in substitution for some of the imperial measures, although it was nearly a century before this was actually done under the present Queen.

The Act is sensibly pragmatic when it says that "*it matters not by what name any particular weight or measure may be called so long as the vendor and purchaser, carrier and bailor [delivery man], and the like, have in mind a specific multiple or part of an imperial weight or measure*". There was a lawsuit on the question of whether the tons specified in a contract for iron, were for "long weight", where a ton contained 2,400 pounds instead of 2,240 pounds. [The subject-matter and the lawsuits are very similar to those covered by Roberts in his *Handbook of Weights and Measures*, London, 1908.]

At a time when most groceries were sold loose by weight, it is pointed out that the placing of a paper bag under the goods on the scales invalidated the process of weighing, even though the customers knew that the weight of the paper was included. The custom of weighing on or in a bag was so common, however, that the defence could claim that it was a custom universally recognised by purchasers. But a purchaser who *stipulated* 4 ounces of tea net weight had to be given precisely 4 ounces net weight of tea *plus* the weight of the bag containing it.

Great emphasis is placed on the need for every outlet selling goods by weight to have accurate scales, and details are given of the penalties for using false scales.

The space devoted to certain commodities stresses their importance. The capacity of casks was sometimes diminished by coopering [the repair and patching up of casks], and brewers were expected to be aware of this and state the true capacity. Several pages are devoted to bread. A customer who asked for a quartern loaf [four pounds after1836] had to receive at least that weight. A 2lb loaf which had been weighed at 6.30 a.m. but was not sold until 6.30 p.m. caused problems for one particular baker because it had lost weight by drying out during the twelve hours.

Coal, however, seems to have caused the most problems, judging from its lengthy discussion. (EQM, 32-34, and 130-133). At least if it was sold by the boat-load, or wagons or tubs direct from the colliery to the customer's works, it did not have to be weighed, if the purchaser gave his written consent.

Through the pages of careful definition and discussion, we get the impression that there was often a running war between coal sellers and inspectors of weights and measures. An inspector who had one coal-merchant successfully prosecuted for having false and unjust weights and scales was promptly accused by one of the witnesses for the defence of not following the correct procedures. A hawker of small amounts of coal was prosecuted after he refused to weigh a bag of coal under a local bye-law which meant that the vendor might have to weigh the coals over and over again - possibly at the request of every constable in the area. It was decided that the bye-law was unreasonable, but one wonders if this was a case of a small trader who finally got fed-up of being picked on by certain police-officers.

Informers could receive up to a moiety [half] of the fine imposed on a coalman who sold short weight. Inspectors could not receive this reward by this date. Very sensibly, while they acted as inspectors they could not profit from the "*making, adjusting or selling of weights, measure, or measuring or weighing instruments*", unless the Board of Trade authorised an inspector to adjust weights and measures, in which case he could charge for his services.

When so many laws cause heated debate or arouse strong opposition, it is very comforting to read of laws whose sole purpose was equality, honesty, and the protection of the customer. Who would criticise the Weights and Measures Acts - except a coalman with light weights?

S Holroyd

Review

Special Aspects of Coin-Weights, by Gerard M M Houben, published by the author, at Hugo de Vrieslaan 12, 8024 BM Zwolle, Netherlands. Price 25 guilders or £10 including postage.

The author has rushed out this preliminary work in English, with the admirable aim of showing how the whole of Europe has tackled the problems of light coin from 500 to 1900 AD. Obviously, having only 75 pages, he has been forced to be particularly concise or to omit many exceptional pieces. 92 weights are illustrated, showing examples from the 24 countries covered, but, as there are probably upwards of 10,000 that could have been shown, the illustrations are intended as a sample not an education.

The text covers Identification, Weighing, Relationships between weight types, Various Countries' Weights, Manufacturers, Boxes, Museums, References, Indexes and a Glossary, all subjects which need consideration and study. The necessity to be brief has resulted in many generalisations, and some uses of the English language that lead to misunderstandings. 13 pages were left blank, which could usefully have been utilised to space the text nicely, to improve the lay-out (which runs off the top of the pages sometimes) and to expand some of the more imprecise statements.

George Mallis worries that, while the U S silver Dollar of 1783 is correctly stated by Houben to subdivide decimally, none of the coins authorised by that legislation was ever actually minted for circulation. It was the Dollar specified by Congress in 1792 (and first minted in 1794) that divided into one hundred cents, for which weights were needed. Mallis also points out that in about 1702, the English passed a Law prohibiting the Colonialists from paying a premium for English silver shillings, but that Colonialists circumvented the prohibition by making their own weights with which to buy 10 shillings-*worth* of silver. The authorised weights would be 900 grains each, but theirs were 700 grains, so building in a premium of about 25%. Ingenious! Houben dates the first American gold rush at 1740, whereas it started in 1802.

British collectors will argue with Houben about the metals from which the weights were made. Pewter, lead, cupro-nickel, copper, silver, bronze and gilt-brass weights appear, from a British perspective, differently from Houben's views on them.

Withers discusses the distinctively English way of making mediaeval weights, by using one die and a round flan, punched onto various thicknesses of copper, to produce the quarter, half and whole noble. Houben considers these to be Continental in origin and he does not agree with the Withers as to the earliest dates for English coin-weights. Houben lists two Bank of England Dollar weights as American.

All readers of EQM in 1994 will be surprised by Houben's categorical statement that no boxes are known for Irish weights, and that Troy weights were exclusively for use by the Mint and the gold and silver trade, forgetting bread and spice weighing. Houben's statement that Crawforth published names of coin-weight manufacturers is wrong, as she knows only about scale-makers.

As the author plans a second, heavily-revised version, the reviewers do not intend to discuss it all, but anybody buying it should know that this book needs some revision before it lives up to its title.

G Mallis and D F C-H

Review

Marks and Marking of Weights and Measures of the British Isles, by Carl Ricketts with John Douglas, Taunton 1996. ISBN 0 9528533 0 2. 280 pages, two columns of fine print on A4 paper. 39 figures, 2 maps, photographs of 72 whole objects and 60 pages of tables. About 1400 drawings of marks. 126 pages devoted to W & M authorities and their verification marks. Available from the Publications Officer of ISASC Europe, at £33 including postage, or from the author, Carl Ricketts, Barton Oaks, Bickenhall, Taunton, Somerset, TA3 6TX, UK at £33, including postage by 1st class in UK, by air to Europe and by sea mail to the rest of the world. No foreign money or cheques accepted.

Some of the earliest questions about verification marks were raised by qualified Inspectors of Weights and Measures, in their *Monthly Review*, nearly a century ago. This work was collected and extended by Harold Speight, particularly in the period 1927-35, and continued by Maurice Stevenson, who remained actively interested in the subject until his death in 1996. Some of Stevenson's work was published in the second edition of the Shire Album on *Weights and Measures* (1987), and ISASC members will recall that in 1978-79 EQM contained a number of articles by Michael Crawforth, with drawings of about 150 marks. The growth of interest in all aspects of historical metrology encouraged many of our members to take an interest in the subject, and in 1994 the reviewer began to collate the information which he had discovered. The need to understand the background led to five articles in EQM (1995-96); an extended version of which was published recently in book form, *Verification Marks on Weights:- the Administrative Background*. See Review on page 2112.

Concurrently there had been growing interest among those who collect measures, especially pewter measures. This has now born fruit, with the publication of a splendid book written by Carl Ricketts, with John Douglas' help. The first part of the book consists of six chapters which explain in detail the legal and administrative context for the use of verification marks, covering the entire British Isles. This is by no means a simple matter, since there were numerous local authorities which claimed the right to stamp weights and measures, and the mechanisms by which the stamping was carried out were many and various. This account is supported by several extensive lists, several of which are published here for the first time. They include a list of the standards issued and the corresponding indenture numbers, from 1825 to approximately 1894, and a list of the uniform verification numbers issued from 1879 to 1980, including details of those confusing cases where a number was used by more than one authority.

The second part of the book is a geographical listing of all known weights and measures authorities from 1826 onwards. For each authority there is a brief account of its activity in the matter of weights and measures, accompanied by illustrations of the mark or marks used by that authority. This is the part of the book which will undoubtedly be welcomed by all collectors of weights and scales. There are a

few obvious errors (Middlesex was not completely abolished in 1890!), and in several cases I would have preferred to see a clearer indication that a mark is only tentatively identified with a specific locality. But these reservations should not detract from the immense amount of definitive information recorded here. Among the localities for which a mark is positively identified here (for the first time, as far as the reviewer knows) are the following:- Anglesey, Cardiff, Stockton, Bury, Glossop, Ludlow, Dartmouth, and Dunstable. In all these cases there is strong evidence to support the association of the mark with the locality. The reviewer is sceptical about a few other suggestions: for example, the mark suggested for Enfield is almost certainly a Birmingham maker's mark, and the GR over TD mark seems to be too common and too widespread for a small place like Tavistock. On the other hand, there is an original and very convincing explanation for the hitherto puzzling use of the numbers 318 and 327 with the Manor of Wakefield mark.

Given the existence of this comprehensive listing, it is, perhaps, important to stress that there are still many unanswered questions, both general and specific. There are several local authorities who almost certainly stamped verification marks on weights and measures in the middle of the nineteenth century, but for whom the mark issued has not been positively identified. Many of the municipal boroughs in Devon and Cornwall come into this category. On the other hand, there are a number of marks which turn up quite often, but cannot yet be assigned to a local authority. Another problem is the dating for the marks used by the county authorities, since in many cases these marks were changed several times in the nineteenth century.

The ISASC project had covered some of the same ground as this book, and there is some overlap. However, there are also many places where the two approaches are complementary, and there are some questions about verification marks which are particularly amenable to the combination of weight-lore and measure-lore. For example, there are several recorded marks which could be maker's marks, rather than verification marks: but a mark which occurs on brass weights as well as pewter measures is almost certain to be a verification mark, because it is unlikely that there were manufacturers who made both brass weights and pewter measures. Conversely, a mark which appears exclusively on one class of object is almost certainly a maker's mark. Another area where the pooling of information may be helpful is dating. A mark which is never seen on a bronze weight is unlikely to have been in use before 1835, whereas a mark recorded on the convex-edged style of brass weight must have been in use after 1852, when the design was registered. There are similar key dates associated with innovations in the construction and design of measures. Clearly, by putting the two sets of key dates together we can derive better information.

Even so, there is much that will remain to be done after the existing knowledge has been pooled. The larger non-county authorities, such as Manchester, Birmingham, and Liverpool, have histories of weights' and measures' activity as complex as any county, and would repay closer study. Many of the smaller authorities, such as the Liberty of Cawood, Wistow and Otley, and the Liberty of Romney Marsh, are now almost forgotten, and their activity in stamping weights and measures is their most abiding legacy. Some quite unsuspected byways in local history may be uncovered by this approach.

Usually the publication of an informative book like this one leads to even greater interest in its subject matter. Thus it is almost certain that the next few years will see the resolution of many open questions about verification marks. Let us hope that the collectors of weights and scales will join with the collectors of measures in carrying this work forward.

N Biggs

The editor is not as familiar with the details of the subject as the reviewer is. She has had recourse to this book many times since it was published, but has had problems finding the desired information because the indexes are minimal.

Fourteenth-Century Weights Systems: A Response

By A D C SIMPSON and R D CONNOR

In the last issue of *Equilibrium* (EQM, p. 2067), Mr Geoffrey Newall commented on some aspects of our recent paper on early North European weight series (EQM, p. 1987-1998, 2015-2024), and the Editor has invited us to reply.

Although we appreciate the nature of Mr Newall's concerns, we believe they are misplaced. To some extent we may have brought this on ourselves by trying to develop a relatively complex argument within a very restricted length, but we had been anxious to respond positively to the suggestion that we should publish this in *Equilibrium* because Professor Norman Biggs had been party to our evolving ideas on this topic and because its first public airing had been at an ISASC meeting that he chaired. However, the present charge is one of statistical naivety - not a concept which is happily embraced by two trained physicists - so a response is necessary!

The thrust of our article was as follows. Until recently, it was the received view of early weighing practice in England that commercial pounds were troy pounds of 15 and later 16 troy ounces (of 480 troy grains), with the addition of the current avoir pound from perhaps the 15th century. Professor Biggs significantly changed this picture in 1991 when he pointed out that there was no evidence for the formal use of troy weight in England until the late 14th century. Our use of Scottish and English sources has convinced us that before this 14th century introduction of troy, domestic weight series had been defined in terms of the 450-grain Cologne ounce (or Tower ounce, from its known use as the monetary ounce in the English Mint), and also that different pounds were applied in the weighing of different goods. The commercial memoranda of Francesco Pegolotti, London manager of the Florentine banking house of Bardi from 1317 to 1321, confirmed this and provided detailed information on the inter-relationship of the weight series at a number of North European trading centres.

Two important conclusions stemmed from this. Firstly, the mass of the woolsack at these various centres was found to be the same, although expressed in terms of the weight of different national pounds - and this seems a natural feature of an essentially international trade. Secondly, the pounds used in London for different commodities were combined in large multiples known as 'hundreds' for trade at a wholesale level, yet the mass of the various hundredweights was the same, and this characteristic London hundredweight bore a simple relationship to the trading hundredweights of other North European centres. Achieving this level of simplification in trading calculation suggested that the approach had been correct.

The picture had now been transformed. Instead of expecting to find English weights of perhaps only two or three types, it was now clear that a range of weight systems were in use in England at that period, a number of them certainly influenced by the systems of England's trading partners. We showed how the pound types potentially available were based on a small number of bullion ounces, combined in different multiples with each multiple often having a characteristic use. Thus, in the English weights based on the Cologne (or Tower) ounce, the monetary pound was defined as a 12-ounce pound, the goods pound was of 15 ounces and the wool pound was of 16 ounces.

The existence of a 14-ounce Flemish pound (also used in England) has been noted by many commentators on Pegolotti's work, but 14-ounce pounds do not feature in works on Low Countries' metrology, which appear to deal exclusively with the later 16-ounce pounds. Most obsolete standards did not

survive the 18th- and early 19th-century reforms surrounding the introduction of the metric system, and so it was welcome news when Dr Gerard Houben was able to tell us about the small group of weights in the Gruuthuse Museum in Bruges based on a 14-ounce pound size.

Mr Newall argues that the figures we give for these weights in Bruges (which are not ours but were taken from Dr Houben's letter) match the postulated standard too exactly: in his experience a considerable weight loss would be expected through wear. But here he compares two very different situations. It may well be the case that a group of 17th century trade weights in his collection, controlled in use within an unspecified adjustment range, show the amount and variation of wear he described. But it does not follow that weights which may have had the status of municipal standards in their day will have been exposed to the same rigours of use and deteriorated to the same extent.

Indeed surviving sets of early weight standards often exhibit remarkable internal consistency, showing that they have been retained in adjustment and have remained largely untouched after they became obsolete. As an example of the type of accuracy that might be expected in a retained official weight, one might cite the early brass pound of 12 x 450 grains found in the pyx chamber at Westminster in 1842, and described by W. H. Chisholm as of the late 13th century in his 1873 *Seventh Report of the Warden of the Standards*: this weight was only 9 grains light when its mass was published in 1864 (a figure which may be reduced still further if, as currently seem likely, the early English monetary pound was marginally under the accepted modern mass). It should be stressed that early standards of this type have normally survived only by the chance of having been discovered languishing, long-forgotten in cupboards and chests where they have not suffered from the corrosion familiar in archaeological finds.

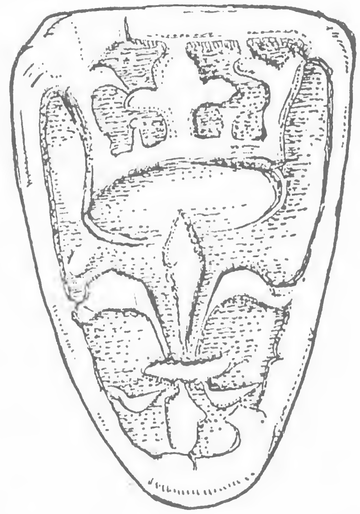


Fig. 1. Half-pound weight with crowned fleur-de-lys motif, found by Jim Halliday at Malton, North Yorkshire in 1994. At 232.1 g (3582 grains) this is presumed to be half a wool pound of 16 x 450 grains. The motif is also found on avoirdupois weights.

Full-sized drawing by Anne Hodgson at ARC.

Reproduced by permission of the Archaeological Resource Centre, York (shield-shaped weight reference 3.6).

However, for our argument, what matters is not the precise mass of the Bruges weights (because this raises far more complex problems in deciding the size of the contemporary standard), but the fact that the pound represented in the weight is unambiguously one of 14 ounces.

A similar argument applies to the quarter-pound shield-shaped weight of lead shown in the second figure of our article. A number of the items which are now being excavated and which are recognisably weights, are shield-shaped and carry heraldic motifs on their upper surfaces. They probably represent chance losses of small weights from larger sets being carried by officials or merchants between markets. Because the shape is reminiscent of the later wool weights, there has been an assumption that they are always connected with the wool trade, but in fact their mass is often not compatible with our present understanding of the wool pound.

Lead behaves in a very different way to brass, and in particular it is very malleable and tends to distort rather than abrade when struck or damaged. Providing the design is reasonably clear, albeit distorted or flattened, and there is no evidence of cutting or physical loss of sections, then there is a good chance that little weight loss has occurred.

The principal corrosion products seen in excavated material are the carbonate and basic carbonate, which are slightly heavier than the original lead, and this compensates for some minor loss through wear.

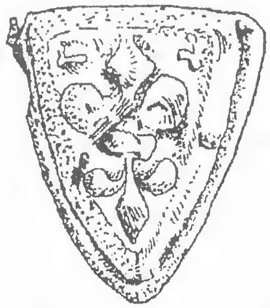


Fig. 2. A smaller and less well preserved weight of an eighth of a pound with a fleur-de-lys motif, of mass 53.6 g (827 grains). Found by Stephen Pickles at Acaster Malbis, North Yorkshire, in 1994, and probably an eighth of a Flemish(?) pound of 14 x 472½ grains, known from the preserved standards in Bruges and from other English finds.

Full-sized drawing by Neil Kay at ARC.

Reproduced by permission of ARC, York (shield-shaped weight reference P.7).

Weight loss during electrolytic conversion can help estimate the thinness of the surface carbonate layer which protects the main body of the weight, and this layer is relatively stable to oxidation because efflorescence tends not to develop after excavation.

For these reasons, the mass of a relatively crisp weight (after careful mechanical removal of surface debris) is a good reflection of its original mass, and this is often (but certainly not always) adequate to infer its type. In the case of the quarter-pound weight shown in the second figure of our article, we can deduce that it is a quarter of a 14-ounce pound (and we can also be confident enough that the ounce is the Paris ounce of 472½ grains).

This illustrates an important principle for us. Previously it has been thought that if a pound was, say, a 15-ounce pound, then the trading divisions would be the 15 constituent ounces, so that transactions at this level of precision would involve calculation with factors of 3 and 5. Hence, it was argued, the pressure to move to the more convenient 16-ounce pounds, where simple binary division was all that was necessary to obtain the trading divisions. Clearly 14-ounce pounds, with a factor of 7, would present special problems for the merchant if the divisions were based directly on the ounce. Because such calculation could not be performed on the contemporary counting board, we can dismiss this as a possibility. This quarter-pound weight, together with other surviving weights, illustrated our contention that binary division was used for the trading divisions when working at the level of pounds, regardless of the ounce multiple employed in the pound's definition. In other words, the weight was intended to be used as a quarter-pound and not as 3½ ounces. An eighth-pound would similarly be considered merely as an eighth and not as 1¾ ounces. Indeed, it is worth noting that within living memory foodstuffs in Britain have been bought by the pound, half and quarter, and only rarely by the ounce.

The outcome of this work has been to appreciate the application in English trade at this period of a wider range of pound types than previously acknowledged, linked in specific ways through their definition ounces, and with binary division.

Since our article was written, we have had the opportunity to test this approach against two sizeable collections of archaeological finds. Firstly, Mr Geoff. Egan of the Museum of London Archaeological Service has kindly given us access to his data on medieval weight finds in London, being prepared for publication under the title of *The Medieval Household*. Although the sample did not include shield-shaped weights of the type we had examined earlier, there were nonetheless a significant number of finds whose mass matched our projected series, including several that could be identified as Flemish. X

Secondly, through the good offices of Mr Jim Halliday and Dr Andrew Jones of the Archaeological Resource Centre (ARC) in York, a project of the York Archaeological Trust, we have been supplied with an extended series of details of metal detector finds of lead shield-shaped weights recorded in the Centre's archives. A good proportion of these have been of sufficient size and quality to enable confident matches to be made to our projected weight types. In particular, a group of weights carrying a crowned fleur-de-lys as shown in Fig. 1, a motif which Mr Halliday has now concluded is restricted to Yorkshire finds, has been found to cover several separate weight series. This allows us to conclude that, X

in this geographical area at least, the motif is a mark of authority rather than an indication of the type of weighing application.

We must emphasise that the purpose of this work is to provide a more satisfactory way of linking the early commercial weight series, and one which introduces greater self-consistency in interpreting the documentary sources and is more compatible with surviving medieval weights. We would hope that this will merely provide the starting point for a more detailed assessment of the material evidence.

Authors' Biographies

Professor Robin Connor is Dean Emeritus of the Faculty of Science, and Senior Scholar, at the University of Manitoba, Winnipeg, Canada, and is well-known to ISASC members as the author of the 1987 volume *The Weights and Measures of England*. His work is supported by the Social Sciences and Humanities Research Council of Canada, and by the Research Board of the University of Manitoba. Professor Connor is also been concerned with the early metric system, and European members will be interested in his paper 'The Development of the Metric System' published in *Physics in Canada*, vol. 48, 1992, p 191–206. For information about Dr Allen Simpson, see EQM, p. 2072.

From the Editor:

Allen Simpson and Robin Connor look forward to the contributions to this project that can be made by ISASC members, either in the columns of EQM or by writing to them at the National Museums of Scotland, Chambers Street, Edinburgh, EH1 1JF (tel. 0131 2474249; Email adcs@nms.ac.uk) or at The Department of Physics, University of Manitoba, Canada, R3T 2N2 (tel. 204-474-6206). Firstly, the mass of any shield-shaped weight needs to be added to the growing list being compiled, to provide better artefact evidence about the various pounds in use and their trading divisions.

Secondly, Jim Halliday's proposal about the Yorkshire locus for the crowned lys design suggests that other regional designs might be identified. But this can only be pursued if the collection-site of excavated weights is known. If ISASC members do their best to ascertain the area from which their shield-shaped weights originate, getting the dealers to enquire back 'down the line', it may be possible to spot a geographical bias in their distribution. It would have an additional effect of giving dealers some leverage in their attempts to buy only items of legitimate provenance. Which illegal metal-detector user wants dealers who say 'My customers need to know where this was found'? Obviously, in practice, the answer ISASC members will get will be 'Near Colchester' or 'In the River Wear', but that would be helpful to this research.

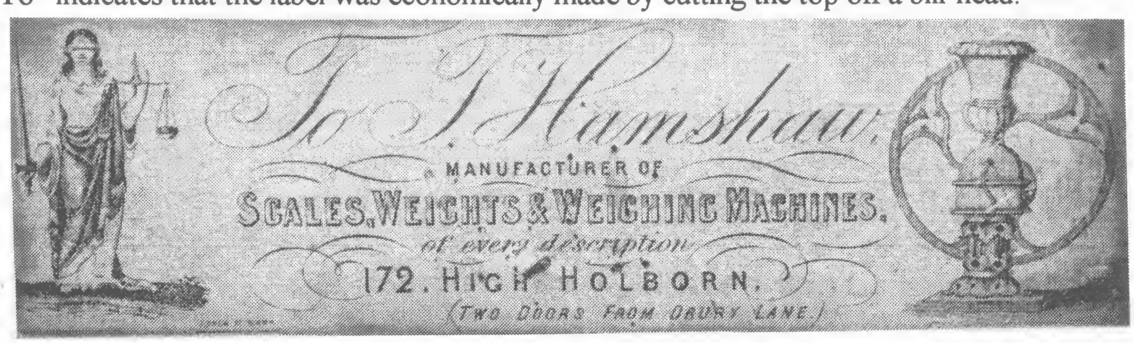
Notes & Queries

N & Q 130	from V Denford

I recently bought a tea scale in an oak MUB box, with a steel beam 130 mm long, with box ends. The trade label is shown below. Who was T Hamshaw, when did he live, and what else did he make?

Reply — from the editor

Thomas Philip Hamshaw was in Trade Directories from 1865 until 1875, trading from 172 High Holborn. Prior to that he was at 477 Oxford St, at least from 1855-1860. He was succeeded by Thos Hamshaw & Sons in 1885-1910, still at 172 High Holborn. No other work known. See EQM, p 1739. The "To" indicates that the label was economically made by cutting the top off a bill-head.



Notes & Queries

N & Q 131	from B OLIVER

In response to your query, I have attempted to find some solid information on the accretions that form on ancient lead. I have been unable to find the reference that I was looking for, so I went back to my basic chemical texts.

Freshly-cast pure Lead oxidises over the first few months to form a thin whitish film, said in some sources to be Lead Oxide (PbO) and in others to be the basic Lead Carbonate $2PbCO_3Pb(OH)_2$. I suspect that the exact composition depends on the environmental conditions. However, all sources agree that the film of corrosion-products forms a protective layer which then inhibits or even totally prevents further oxidation. (The surface is said to be "passivated" when in this protected, oxidised condition.) This is the reason for the generally inert nature of Lead, and why it found such extensive use in the chemical industry for drains, pipes and tank-linings.

Obviously, the formation of the surface layer of oxide etc. will give an increase in weight. The film is *very* thin, often transparent and making the metal look merely dull, so the increase in weight will be very small. As a proportion of the total mass, this increase will be less for the larger weights.[1] I recall that your query related to mediaeval traders' large weights, so the practical error due to surface oxidation alone is probably negligible. Alas, there are no data on film thicknesses that I can find, so we cannot put any numbers on it.

Now let us consider what happens to Lead weights in use. As you know, Lead is very soft and malleable. If a weight was dropped or otherwise thumped, the surface would deform, and the film would probably deform with the Lead:- no change in mass. If the film cracked, further oxidation would seal the crack up with a minute weight gain. If the surface film was abraded lightly, there would be a small loss in weight, followed by a slow gain over succeeding months until the film was restored:- no overall change in mass. If the weight was abraded by a sharp object such as a stone or nail, it might carve off a minute fragment of Lead as well as film:- instant mass loss followed by a much smaller slow gain. It seems to me that the question of stability turns entirely on how the weights were handled and stored. If the weights were merely bumped against each other, or against smooth wood or leather, I suspect that the wear (i.e. loss of mass) would be very low;- only plastic deformation would occur. If the weights were roughly handled and came into contact with rough or sharp objects, then loss of mass would occur.

Most wear would presumably occur on the underside. I would suggest that microscopy of the undersides with a modern stereo-microscope might be useful. Many deep angular scratches would suggest progressive loss of mass; very fine scratches, smooth dents and bumps would suggest no serious loss. We have now strayed into an area within which I have no competence;- do you know any helpful microscopists?

There are two other aspects that should be considered. First, all of the above refers to pure Lead, but medieval Lead was far from pure, containing Silver, Gold, Copper, Tin, Antimony, Arsenic and Sulphur. (Some Lead ores contained very significant amounts of Silver, and that sweeps us off into the realms of Alchemy - another story.) Secondly, none of the above should be taken to apply to any Lead weight that has been buried in the ground. The situation here becomes very complex, depending critically upon the chemistry of surrounding soil, and there are many types of soil. I suspect that corrosion-products would form very rapidly, but some of these would be soluble in the water of wet soil, leading to a fairly accelerated loss of mass. If the soil dried, then the weight would be covered in a thick layer of loosely-

bound corrosion-products which could easily be lost during excavation. On the other hand, Lead weights exposed to carbonate or sulphate would form insoluble films giving a high degree of protection. The relative gains and losses would depend totally on the exact conditions. I cannot take this any further, nor can I in respect of the effects of impurities. But I recommend that you consult Tylecote![2]

Notes and References

1 Consider a set of Lead weights as spheres. The surface area increases as the **square** of the radius, but the volume increases as the **cube** of the radius. So the surface area per unit mass decreases as the spheres get bigger. Conversely, the tiny little spheres of Lead shot have relatively huge surface areas, and the surface film becomes a serious source of uncertainly in mass. This is one reason why the use of hollow laboratory weights adjusted by internal Lead shot was abandoned: unexplained mass changes occurred. We are talking here only of milligrams and micrograms, serious only to analysts.

2 Tylecote, R F, *History of Metallurgy* pub. The Metals Society, 1976.

Review

Apothecaries Weights - an outline catalogue, by Norman Biggs, White House Publications, 1994. ISBN 1 898310 01 7. 36 pages, 112 black and white photos. Available from Galata Press, Old White Lion, Market St, Llanfyllin, Powys, FY22 5BX. Price £5.00, including packing & postage.

This is the second in the author's series outlining English weights and is the reviewer's favourite. As with all Biggs' writing, it is plainly written, in lucid prose, unambiguous and easy to follow. His enthusiasm shines through, and the co-operation of Bente and Paul Withers (doing the photography and giving their advice on presentation), makes this an eminently usable book.

22 early weights from the Mediaeval period to the 17th century are shown, but 90 are 19th and early 20th century weights, square, round or octagonal. Each variation is allocated a unique number (as the Withers did in *British Coin Weights*) and spaces are left for ones not found yet. It was simple for the reviewer to go through the apothecary-boxes and match weights to Biggs' numbers. It was a credit to Norman Biggs to find only six not in his book.

Brief comments are made on each type, dating them where possible, and giving details of makers when known. The annotated bibliography is helpful (and makes one ponder on the time Norman spent in reading). For any collector with apothecary weights, this book is essential.

Verification Marks on Weights - the Administrative Background, by Norman Biggs, White House Publications, 1996. ISBN 1 898310 03 3. 76 pages, 40 black and white photographs of weights or marks. Numerous drawings of marks. Available from Galata Press, Old White Lion, Market St, Llanfyllin, Powys, FY22 5BX. Price £9.00, including packing and postage.

This is the fourth book in the author's series (see EQM, p 1661 and 1937 for their reviews), and although it incorporates the five articles that appeared in EQM during 1995 & 1996, it has been enriched by re-writing parts, adding a fascinating 10 page Prologue, and using 40 excellent black and white photographs taken by Bente and Paul Withers. A very complex subject, handled insouciantly.

Norman Biggs has reproduced the marks in their original sizes, in a different order from those in EQM, and consecutively numbered, but without an index, so the reader has to search for any mark in which he is interested. Obviously, he has included only a sample from those that could have been shown (Ricketts shows 1400) as the text is the important part of the book, but they give the flavour and variety, set the historical background, and obliquely demonstrate the extreme importance of the inspector's role. Another concise, helpful book, of great erudition. D F C-H

ISASC

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Cover Picture

This Makins prototype assay balance is in the Science Museum, London (Accession No. 1898-68). It was built in 1851 or 1852. The case is of fine French-polished mahogany, fully glazed, with all the original glass still present. The door-, drawer- and release-knobs are all made of solid ivory, as is the graduated chart between the pillars. The circular pan-arrestors have solid ivory outers with inner buttons of translucent grey agate. The insert, (the protective layer over the balance's baseboard) is made of a clear glass over pale green fabric, which gives a nice contrast to the mahogany case. The pillars, beam and the rider bars are saffron-lacquered brass, so they gleam richly.

The case is very large in comparison with the mechanism, being 18¾ x 19¾ x 13½ inches (474 x 500 x 345 mm). The front door-slide is counter-poised on the sash principle, with the lead sash weights running inside the rear corner supports. The large headroom above the balance is to allow a service engineer to remove the beam and its attached long pointer from the mechanism without bending the pointer. The feet of the case are screw-threaded so that each can be minutely adjusted to make the case absolutely horizontal as indicated by the brass-cased spirit-levels fitted to the pillar base.

This balance was built to carry a load of 10 grains (648mg) with a resolution of $^{1}/_{1000}$ grain (0.065mg). The huge centre release/arrestment knob has a most unusual vertical action (rather than the conventional rotary action), but the arrestment is currently seized, leaving the beam free-swinging, a most unfortunate circumstance. But this has allowed the sensitivity to be tested, and the balance will still turn to 0.1mg, not far short of specification.

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G H Makins and the Assay Balance

Part 1

BY B J OLIVER

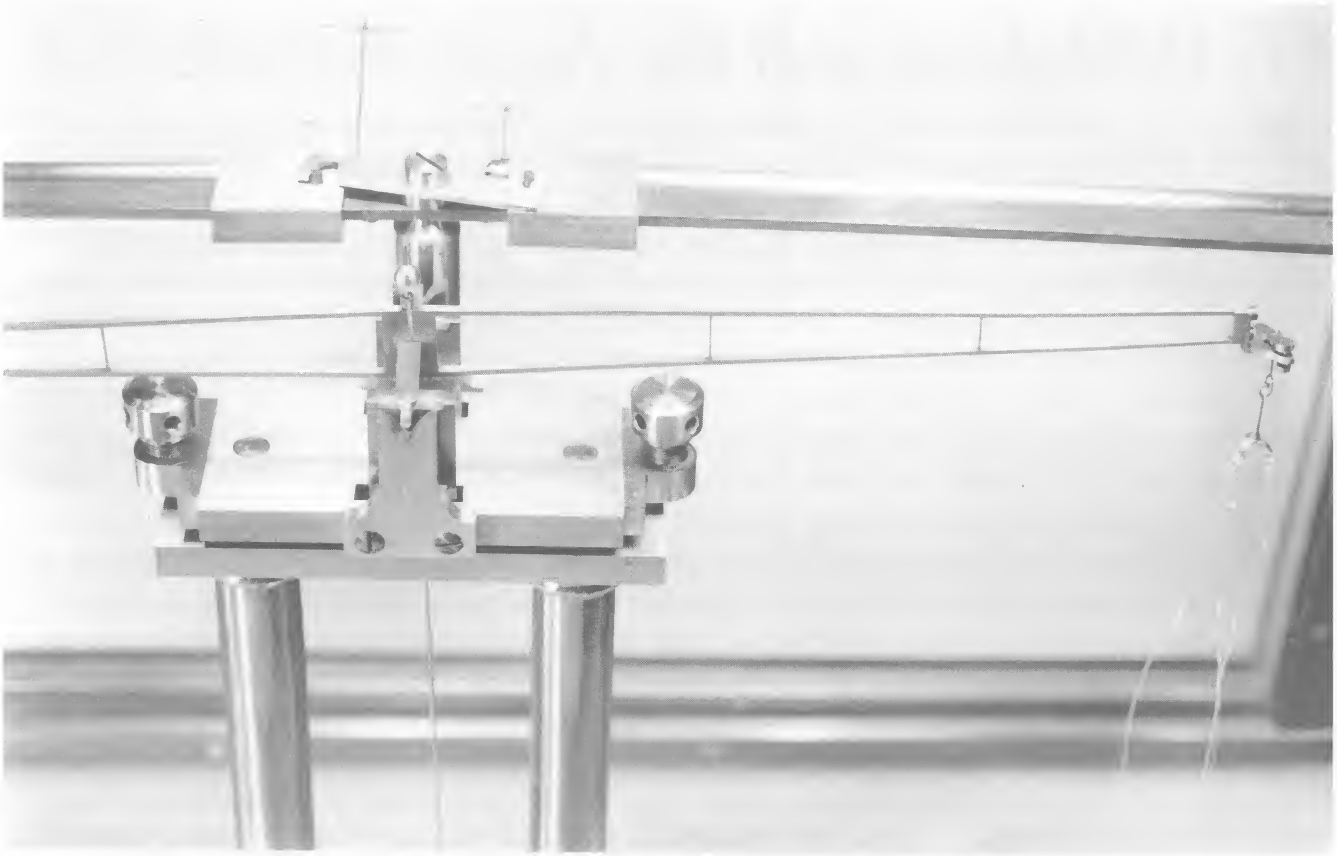
Let me tell you about one of those Victorian polymaths who seemed to pack about six careers into just one human lifetime. Now almost forgotten, George Hogarth Makins was greatly influential in the design of the assay balance in the 1850s; indeed he would now be beyond recall were it not for a small plaque bearing his name, attached to one balance on public display in the Science Museum, London. (Cover picture and fig. 2.) This name was followed up by my friend Dr. Peta Buchanan[1], and revealed a story worth the telling. Not only did Makins revolutionise the design of assay balances, but some of the changes he introduced were transferred to other types of balance, and his influence can be traced right up to the demise of the two-pan, three-knife balance. But let us begin at the beginning.

George Hogarth Makins was born in 1815. An only child, son of a minor Treasury official, he developed an early interest in chemistry, but at that time, the opportunities for adopting chemistry as a profession were very few. After a short spell in a solicitor's office, and an apprenticeship to a medical man, he became a full-time medical student, and passed his finals at Apothecaries' Hall in 1839, and at the College of Surgeons in 1840. However, the pull of chemistry was too great, and he held two consecutive lectureships in chemistry, albeit briefly.

He then became scientific adviser to the famous London instrument-maker, Robert Brettell Bate[8]. One of Bate's specialities was the making of hydrometers for the Excise. In 1849 Makins published his first paper, on the influence of temperature on specific gravity measurements[2]. That is not relevant to us here, but his presence in the Bate workshop is interesting. He cannot have failed to learn a great deal about practical instrument-making[3], which would stand him in good stead for what was to come later. Equally importantly, he may have met there a German immigrant of about his own age, the then-unknown Ludwig Oertling. (There is a distinct possibility that Oertling worked briefly for Bate[3]. If not, then Makins probably met Oertling at or via the 1851 Great Exhibition.)

In the same year as his first publication he built himself a laboratory in Surbiton for the manufacture of pure chemicals. One of his particular successes was his invention for the making of a spongy gold much used by dentists of the period. This led to business connections with the laboratory at the Royal Mint. The chief assayer, Henry Field, suggested that Makins become an assayer, which he did. After study at the Mint, he opened his own assay laboratory in 1853. This was very successful, and he was almost at once appointed an assayer and referee to the Bank of England; he also became assayer to the Anglo-Mexican Mint[6 and 8]. This meteoric progress was due to the accuracy of his work, and due to the numerous improvements he introduced to the art of assaying.

The quality of his work rested, at least in part, on his designing his own assay balance in 1851/2. He published papers on his balance[4] and on his investigations and improvements in assaying processes[5]. Most of his improvements were taken up by other assay offices. But the long hours in the corrosive atmosphere of laboratories took their toll (he had never enjoyed good health) and he retired from business in 1863, aged only 48. He continued to lecture for another 20 years, brought out his Manual of Metallurgy and its expanded second edition[6], and became very influential within several professional bodies. Not only was he a member of the Society of the Chemical Industry



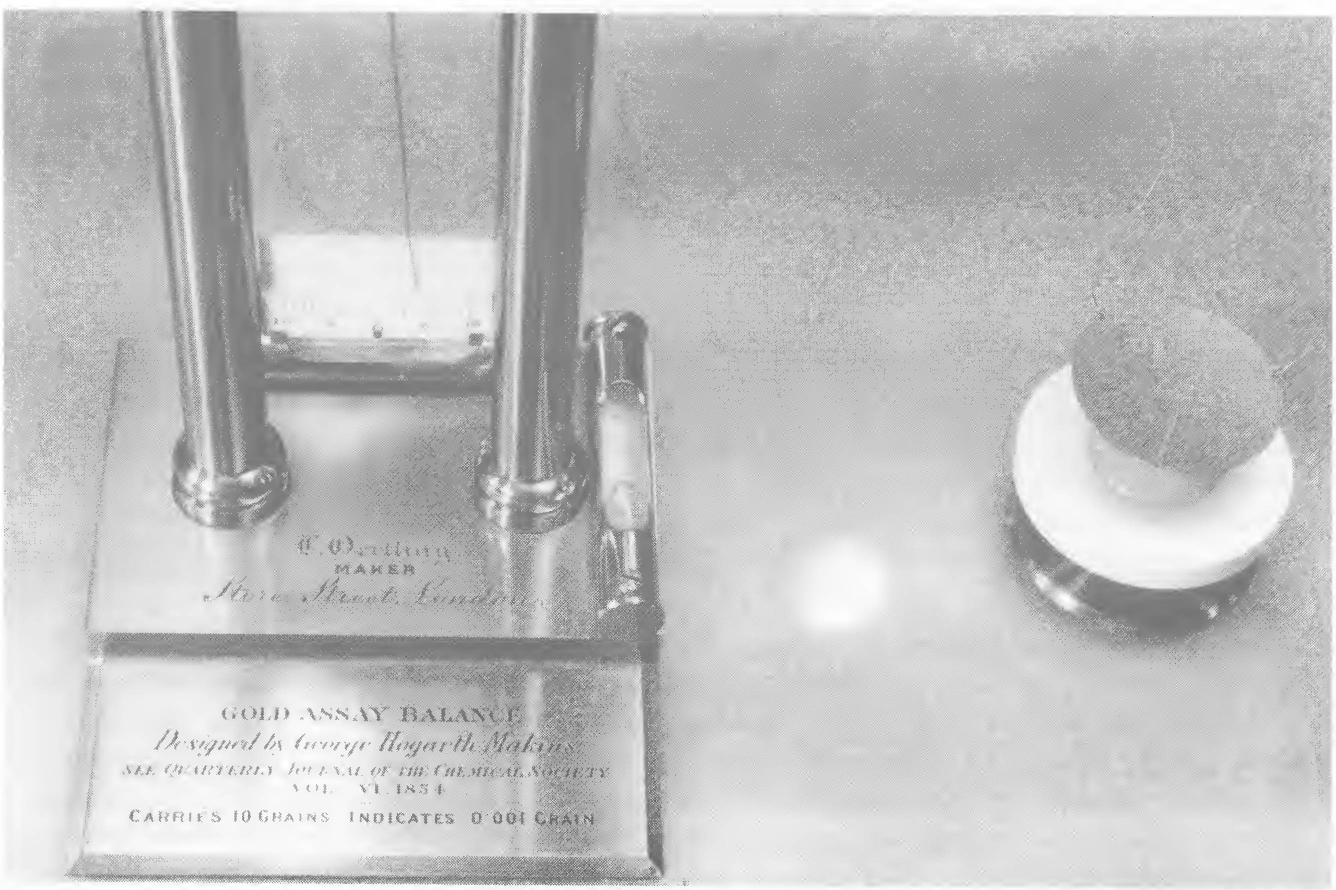

MAKER
GOLD ASSAY BALANCE
Designed by George Hogarth Makins
CARRIES 10 GRAINS INDICATES 0·001 GRAIN

Fig. 1. ◀◀ Upper half of Makins' prototype. Note the fragile skeleton beam, and the two adjustable stops ('capstans') at the extreme left and right of the upper table, intended to arrest the beam precisely, but no longer operating. The distorted chains are spaced by a minute spider below the end-bearings.

Fig. 2. Bottom. Lower half of Makins' prototype. The brass pan is hung on platinum chains but has insufficient mass to keep the chains taut. The standard Oertling pan arrestors are already present in their final form, with domed agate centres and ivory outers. The plaque that started the hunt has the journal reference wrong! The year should be 1853!

and of the Microscopical Society[7], but he also became a Fellow of the Chemical Society, and rose up through the ranks of the Society of Apothecaries to become no less than Master in 1869. He died of cancer in 1893 at the age of 76[8].

The assay balance has a long pedigree. First conceived as a tool for heavy metallurgical purposes, (one thinks here of the woodcuts in Georgius Agricola's *De Re Metallica* of 1556), it was miniaturised and refined into a balance for control of coinage metals (e.g. as shown in Lazarus Ercker's treatise on the art of assaying, of 1574). The assay balance in England up to the time of Makins consisted of a slender iron, steel or brass beam on the finest steel centre knife currently possible, with a limited degree of bearing relief. Progress in design was very slow.

By the mid-19th century, a typical goldsmith's assay balance would have a rod beam, some 10 ins long, semi-relieved end bearings, box beam ends, a capacity of 30-50 grains (2-3 grams) and a resolution of perhaps $^{1}/_{50}$ grain (say, 1 mg) at best. These were the sort of devices that Makins would have encountered in the Royal Mint, and with which he soon became dissatisfied. But he would also have found there two superior balances, by John Field, the father of Henry Field. We also bear in mind that he would have handled, or at least seen, many types of scale and balance in the Bate workshops.

I have the impression of a man never content to stand still, and he conceived the need for a better assay balance in order to improve the precision, and hence the accuracy, of assaying in general, and for two special projects in particular. His intention of using pure gold and silver plate for reference purposes in assaying, instead of conventional "trial plates", and his investigation into small but

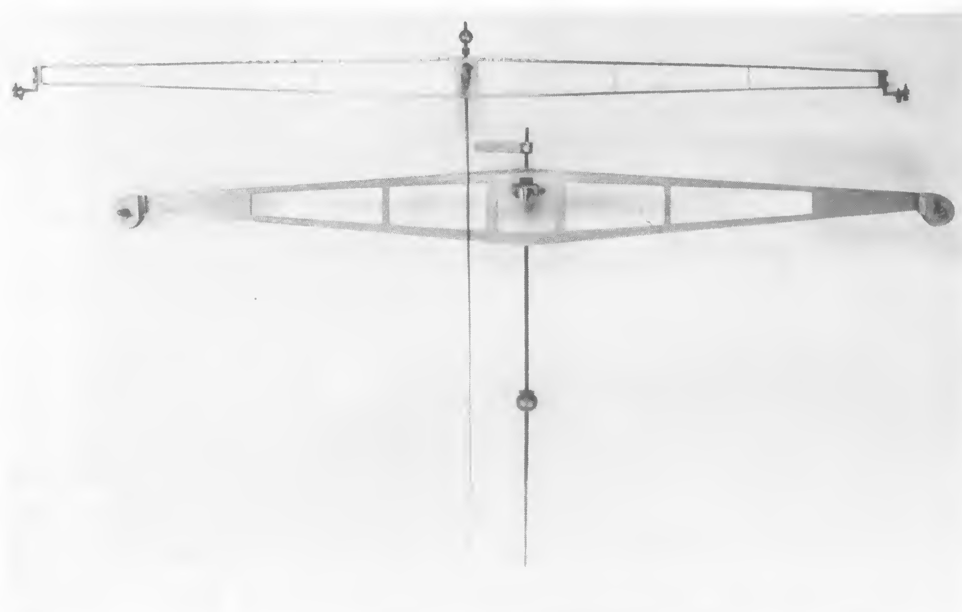


Fig. 3. The Makins production beam at the top, compared with another beam of about the same date. Both were intended for very fine precision weighing.

definite losses of gold and silver in the actual assaying process, both led him to need an assay balance of greatly enhanced precision, say $^1/_{1000}$ grain (0.065 mg). He must have drawn on his workshop experience and, I do not doubt, was greatly influenced by the Field balances at the Mint. But, most of all, he clearly discussed his ideas with Ludwig Oertling.

We do not know exactly how much each man put into the radically new design, but there is no doubt that Makins was the instigator, and that Oertling agreed to make several prototypes for him in 1851/2. These had a nominal capacity of 10 grains (648 mg) and the required resolution of $^1/_{1000}$ grain. Soon, after some modifications, the design went into production. (Figs. 3, 4 and 5.) Subsequently, after some minor changes, the model became the Oertling No. 12, one of the most successful (and lucrative) of all the Oertling models. Within a few years the No. 12 had swept the

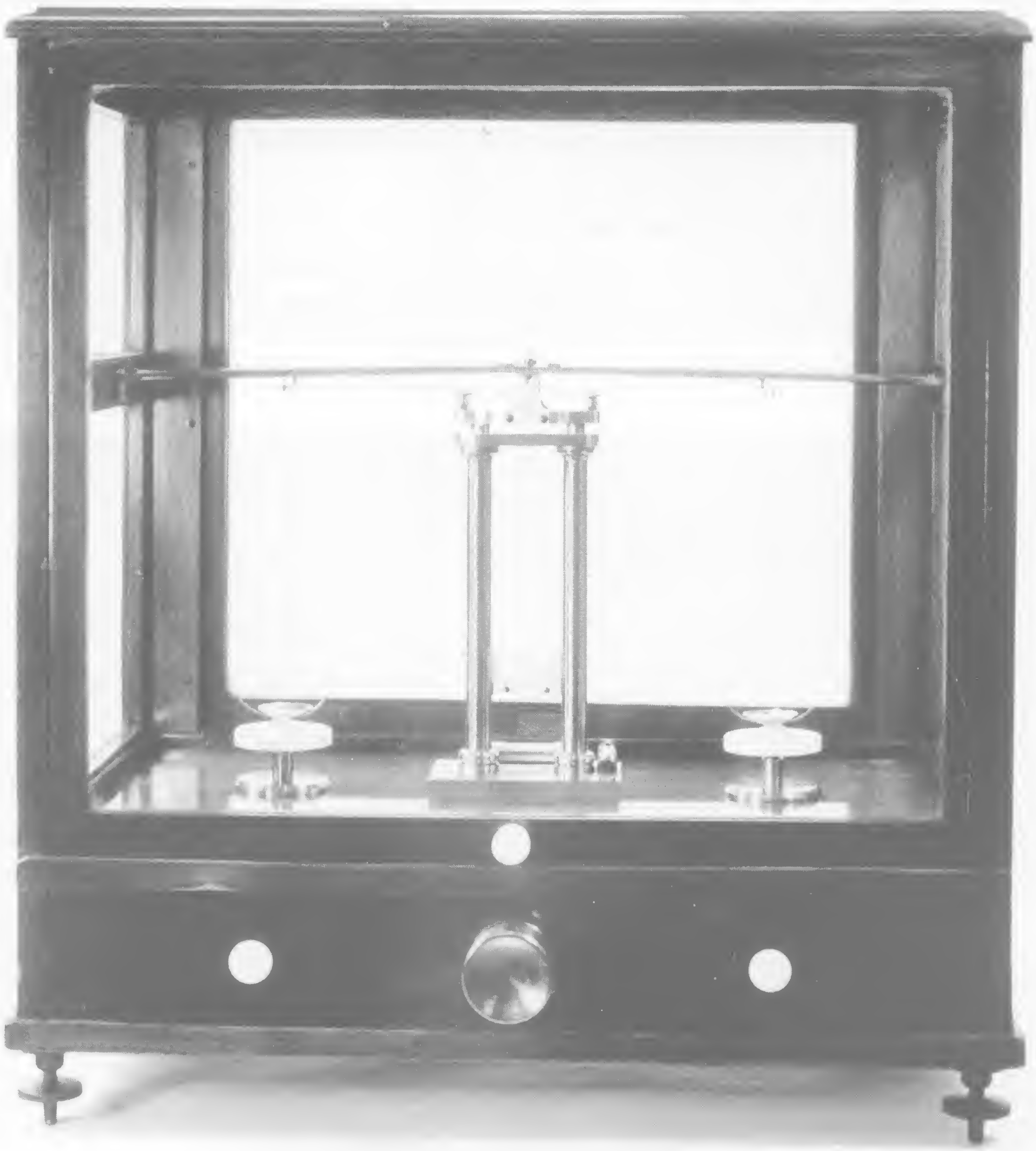


Fig. 4. The Makins' production model. The beam is identical to the prototype, but is now fitted with rigid wire pan-hangers suspended from agate planes. Note the brass conventional rotary release knob. The arrestment 'capstans' are supporting the beam precisely. The pan-holders just 'kiss' the pan arrestors.

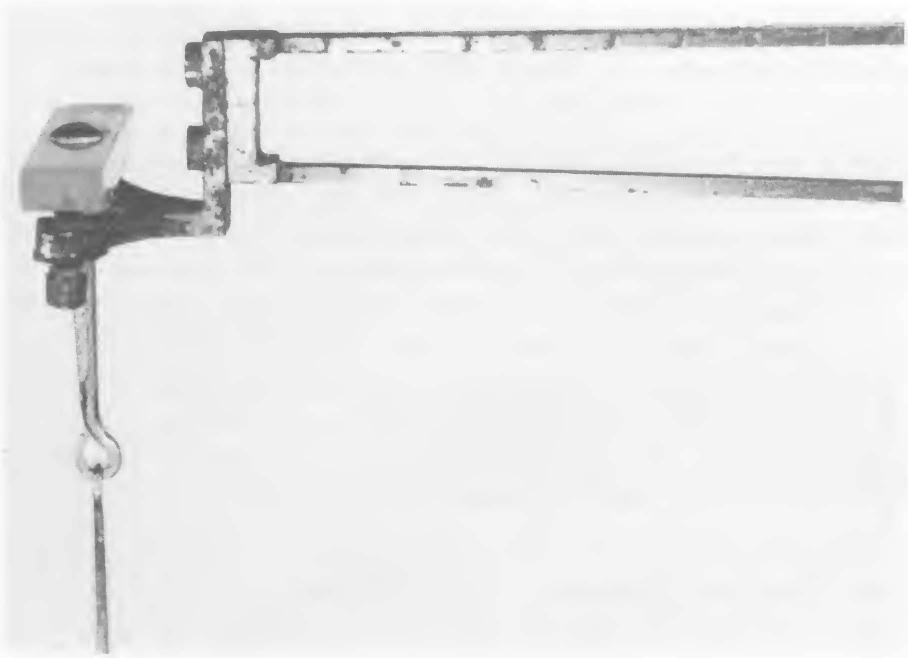


Fig. 5. The bifurcated fitting bolted onto the beam end. The nearer steel pin and its adjustment are just visible. The agate plane and the suspension hook passing through it are very solid. The agate block is 10 x 3 x 2 mm.

The notches for the rider poise are clearly visible, as are the consequences of the corrosive atmosphere in which the balance has been used.

opposition aside, and the design was copied by many other makers, notably in Germany and the USA. But I am getting ahead of myself. Let us return to 1851, the year of the Great Exhibition.

It is quite clear that Makins considered almost every feature of the assay balances with which he was then working, and found them lacking in every particular. I can do no better than quote from his Journal of the Chemical Society paper of 1853[4]. In discussing the existing beams:

But the beams all contain too much metal, and that especially in parts where its presence interferes with their action, by imparting a certain amount of inertia. And, lastly, their stands and movements are very far from convenient.

- by the latter he criticises the way the centre-knife is placed upon the plane. He has clearly thought the whole subject through from the ground-floor up:

The essentials in an assay balance appear to be these: first, that it should be constant, so that certain differences in value in weights should always produce the same difference of indication; secondly, it should be exceedingly quick in indicating; and thirdly, very sensible, and consequently affected by slight differences. These two last requirements are somewhat incompatible, for, in proportion as you increase quickness of action, you must diminish sensibility, by lowering the centre of gravity of the system; and it is in the union of these two necessary qualifications that the value of the balance now before the Society lies.

His most radical innovation was to reduce the mass of the beam to the absolute minimum, thereby increasing the rapidity of the oscillations without the concomitant loss of sensitivity. His own description cannot be bettered, (and see Figs. 1, 3 and 5):

The beam of this balance is what is called a skeleton beam, 10 inches long, ½ an inch deep at the fulcrum, tapering off to $^1/_3$ at each end. It is about $^1/_{16}$ of an inch thick at the centre, decreasing in the same way to $^1/_{20}$ of an inch. As little metal as possible is left in it; thus in the centre, there is but just enough to allow secure fixing for the knife edge; and at the ends, for the adjustments for length of the arm, etc. The latter are effected very much in the same way as in Robinson's balance, in which an oblique saw-cut is made nearly through the metal at the ends of the beam,

which cut is capable of being opened or closed by pressing-screws. In the present case, a loose piece is put on, and made similarly adjustable by screws. Thus we obtain the adjustment for length of arm.

The lattice beam had been invented in the 18th century, and had been used by several makers, including T C Robinson. Makins took the lattice concept to the extreme "skeleton" form, and he did not exaggerate when he said "as little metal as possible is left in it." Note the two exquisitely fine vertical bars per side. These skeleton beams are terrifying for the amateur to handle. The only way to hold them is by the pointer, always. The original beam with all its permanent fittings weighed only 103 grains (6½ grams). Few craftsmen were capable of making such beams. Later, to simplify matters, they were made to a constant thickness, but they were still cut as a single piece from plain brass sheet, and hand-sawn and hand-filed to profile! Many years later, in his *Manual of Metallurgy* [6], Makins quotes the original beam weight as 122 grains rather than 103, and notes that experiments to reduce the weight even further yielded a brass beam of only 84 grains, and an aluminium one of 78 grains!

Makins was obsessed with reducing all bearing surface areas to the absolute minimum, to minimise friction. Thus the tiny fitting bolted to each end of the beam carried two tiny hard steel cones (or "pins") as the bearings, instead of knives; the end plates were tiny steel flats, each with a dimple and groove on the underside to receive and locate the twin cones. (As Makins said in his paper[4], it would be impossible to achieve two dimples to match exactly the separation of the two cones, hence one dimple has been elongated to a groove, and this remained the standard end plane design for many years, in both steel and agate.)

Each end plane was drilled in the centre for the tiny hook upon which to hang the pan-chains (fig. 5). Each of the bearing cones was screw-threaded at the base, and was adjustable vertically. The fully-independent vertical and horizontal adjustments were far superior to any previous form of beam adjustment. Originally, Makins had specified a single point bearing at each end but, on his own admission, he wisely let Oertling talk him out of it. The centre plane comprises two agates, not flats but worked to elliptical profiles to give little more than point contacts with the long steel centre knife. The use of agate is significant; we shall return to this later.

Part 2 will be in the next issue of EQM.

Notes and References

1 Dr. Peta Buchanan, *Quantitive Measurement and the Design of the Chemical Balance 1750-c.1900*, unpublished thesis, 1982.

2 Makins G H, *On the relative expansions of mixtures of alcohol and water under the influence of a certain rise of temperature, and on a new instrument for taking the specific gravities of the same*. Quarterly Journal of the Chemical Society, **2**, 1849, p 224-231.

Editor: Bate worked on hydrometers for most of his working life, and might have helped Makins to address the problems.

3 McConnell, A, *R B Bate of the Poultry, 1782-1847*, SIS, London, 1993, p 28 and 63.

Editor: R B Bate, H Kater and T C Robinson were all deeply interested in the accuracy of precision balances, and in 1825-7 worked energetically together on the problems. See *Phil Trans*, 116 (2), 1826, 1-49, p 9. Did Bate share the knowledge and experience with Makins?

4 Makins, G H, *On an improved Assay Balance*. Quarterly Journal of the Chemical Society, **6**, 1853, p 36-40.

5 Makins, G H, *On certain sources of loss of precious metal in some operations of assaying*. Quarterly Journal of the Chemical Society, **13**, 1860, p 97-102.

6 Makins, G H, *Manual of Metallurgy*, Ellis & White, second edition 1873. His balances are discussed on pp 200-204.

7 Editor: Tony Simcock of the Museum of the History of Science, Oxford, (which holds the huge collection of microscopes owned by the Microscopical Society) reports that the Microscopical Society was mainly composed, at its inception in 1839, of medical men, who used microscopes for their research. Makins would have been welcomed by them, both as a man who "spoke their own language" and as a polymath.

8 Obituary, Journal of the Chemical Society Transactions, 1893, p 754-756.

Acknowledgements

This paper is really the fruit of a team effort. I am deeply indebted to the following for all their help and many kindnesses on this project:

Chris Berridge of the Science Museum for allowing us to examine critically the Makins prototype.

Dr. Peta Buchanan for her pioneering work in balance research in general, and on Makins in particular.

Diana Crawforth-Hitchins for taking all the photographs and for providing much moral support.

Tony Morris of European Instruments for allowing us the run of "The Graveyard".

Thanks are also due to Alison Morrison-Low and Dr. Allen Simpson at the Royal Museum of Scotland, for allowing me to examine critically the Staples Balance during a stressful period when the store rooms were being rearranged or moved.

Thanks also to the librarians and authors who helped with background research, especially Tony Simcock of the Museum of the History of Science in Oxford.

Author's biography

B J Oliver is a Fellow of the Royal Society of Chemistry, and runs his own chemical microanalysis business, C.H.N. Analysis Ltd, in Leicester. Having learnt precision weighing in various academic and industrial laboratories on Oertling balances exclusively, he decided to start collecting these in the 1980s when it became clear that electronic balances were displacing all the traditional types. As well as collecting, he also restores and researches Oertling balances, and is hoping eventually to write the definitive treatise on the marque.

Found in USA – a British rarity BY J R KATZ

An English postal scale, of the poise-collecting or lift-up poise principal, previously known as a registered design only, has been found in the USA. Frederick Gye of South Lambeth (London), registered the design on 19th May, 1840, at a time when everybody was getting excited by the new postal system. However, no manufactured examples of this scale were known to exist until this discovery. Unfortunately, no maker's identification is evident.

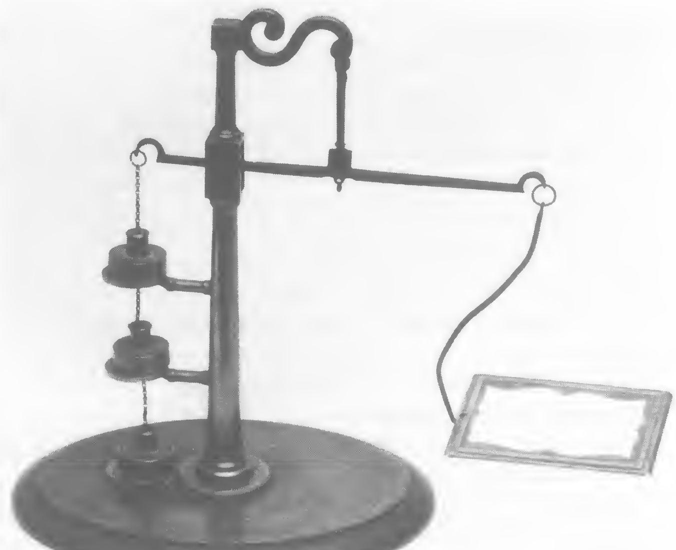


Fig. 1. The only known example of Gye's scale. Photo J Katz

The 10 inch high brass column supports a 7 inch unequal-arm steel beam with swan-neck ends. From the longer arm hangs a brass rod hanger with a 2½ x 4 inch sheet brass letter plate. From the shorter arm hang three knobbed brass poises, two sitting on rests extending from the side of the column and the bottom one sitting on the wooden base. The poises are interconnected by a very fine-gauge chain running from top to bottom threaded through the rests. A brass collar at the base of the column is inscribed "FREDERICK GYE No. 311 REGISTERED MAY 19TH, 1840". The mahogany base is oval, with 8 inch and 6 inch axes.

The principal is straightforward. As the postal load is applied to the plate, the poises seated on their rests are lifted successively from top to bottom until equilibrium is reached. The poises are inscribed 2D, 4D and 6D from top to bottom respectively, and represent the rates in pence for 1oz, 2 oz and 3 oz, in effect at the time (valid from 1840 until 1865).

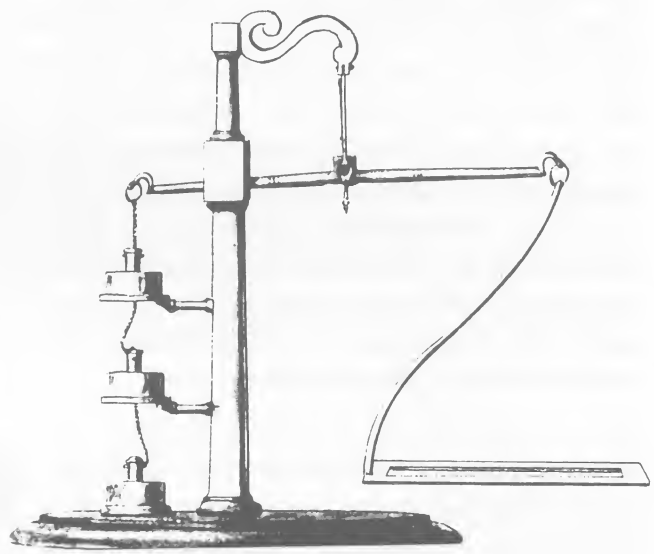
The British postal rates for that period also indicated a rate of 1D for ½ oz. This 1D rate covered all letters that did not raise a poise. When a letter even marginally over ½ oz is put on the plate, the highest poise should rise, although, in practice, it takes 1 oz to raise the first poise, so some

Fig. 2. ^^ Detail of the poises and the escutcheon ring, engraved 'FREDERICK GYE NO. 311 REGISTERED MAY 19TH 1840'. Photo J Katz

adjustment should have been made to the chains' length. (The poise was not itself a full ounce, but it indicated that the postage rate for between ½ oz and 1 oz was operating once it rose.)

With respect to our registrant, nothing is known but that F Gye is given the title "*Gentleman*" on the registry paper. According to the editor, at that time in England "gentleman" really meant "educated man with a sizeable income". Nonetheless, I shall remember him as a clever chap with original ideas.

Fig. 3. vv The water-colour, supplied by Frederick Gye when he applied for a design registration in 1840, has been preserved in the huge book of such designs, kept in the Public Records Office at Kew, London. The original samples (of cloth) or drawings of 3D objects, form a fat scrap book, giving an illuminating view of the early Victorians. Note that the original idea for the letter-plate has been elaborated in practice.



Writer's Biography

Jerry Katz was born and raised in New Jersey. M.S. in Applied Mathematics, Columbia University, N.Y. Career Civil Servant with the Department of Defense, the last 26 years of which were as a Program Manager charged with the design, development and support of Navigational Systems for the Fleet Ballistic Missile Program (Polaris, Poseidon, Trident). Became a part-time antiques and collectibles dealer in 1980. Retired from Federal Service in 1987 and became a full-time dealer. Joined ISASC in 1979, and for more than ten years has served in the role of public liason, answering all scale-related queries addressed to ISASC USA. With wife, Mary, co-chaired the ISASC Baltimore Convention in 1993. Elected Vice President ISASC 1995. Has an especially keen interest in scale-related ephemera and advertising material.

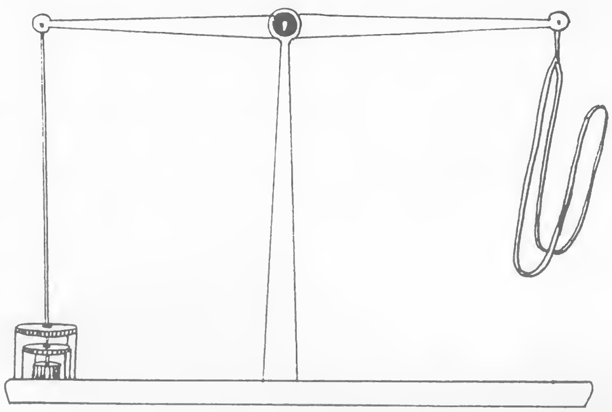
Contemporary Comment, 1840

Mechanic's Magazine, Vol. 33. Anonymous. Drawings based on Registered Designs by D Crawforth-Hitchins.

The recent Post Office regulations having suggested a new problem in weighing machines, namely, to make them indicate rapidly and accurately, not exact weights, but the number of entire ounces next greater than the weight of the letter or packet - this desideratum has been attempted to be realised by numerous inventors. The plan adopted has in every case consisted in the employment of separate weights [poises[1]], so disposed as to be lifted or deposited in succession, each succeeding weight in its turn performing the office of a stop, compelling the index to move through definite steps, in conformity with the new postage regulations. Several contrivances for this purpose have been secured by their inventors under the Designs Registration Act.

In one of these, constructed by Mr. Riddle, (Fig. 3) weights equivalent to one ounce each are deposited on a series of steps placed at short intervals one above the other on an upright pyramidal stem- a large ring beneath the lowest, suspended from the scale beam, lifting them until the accumulated weight exceeds that of the letter, when the index shows the amount of postage to be paid in that case.

Fig. 1. ▼▼ left. The first of the poise-collecting postal scales to be registered. Edmund Beckett Denison registered it on 25th Nov, 1839. Probably the poises stood on legs, so the user was expected to peer under the poises to see how many had been picked up! Possibly the postal rates were conveyed by a chart on the base. Nothing is known of E B Denison. (The address given on the certificate is Lincoln's Inn, the area of London used by lawyers for offices, not for residential or factory use.) Scale not known.



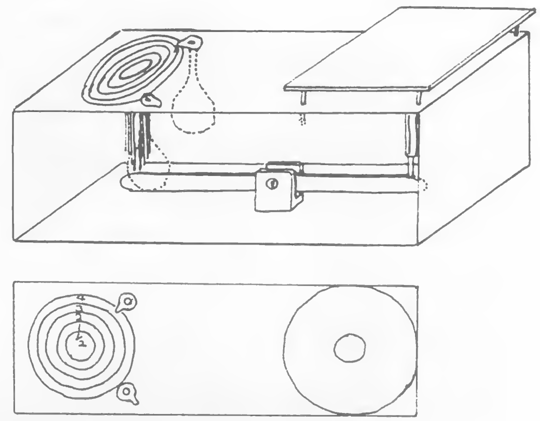
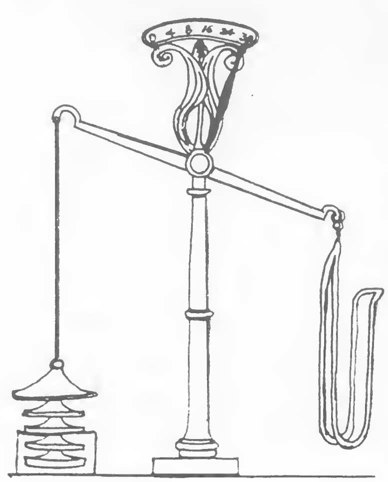


Fig. 2. ▲▲ right. The second poise-collecting registration, by William Lund of 24, Fleet Street, London, taken out on 5th Dec, 1839. Lund was a prolific maker of choice brass instruments and 'toys for men'. This severe-looking box would have been a little easier to use than the scale on the left, in that the poises protruded when picked up by the arm. The rings dealt with letters up to 4 oz, then the hanging poises came into play for heavier letters. By swivelling a latch, a poise was attached to the outer ring, and Lund recommended that as many hanging poises as were desired could be suspended round the outer ring. The lateral forces on the ring when a hanging poise was added must have produced great friction in the sleeve below the ring. Scale not known.

Another machine, registered by Mr. C Griffin, (Fig. 4) consists in a series of metal ring weights (segments of a sphere) rising one within the other, the lower edge of the one taking hold of the upper edge of the next, and so lifting it; each ring being equivalent to an ounce weight.

More recently, Mr. F Gye has registered an instrument of this kind, in which three weights are suspended from the scale-beam by a brass chain, but seat themselves upon three rings placed at different heights so as to be moved in due order at proper intervals of time. This machine is objectionable, inasmuch as the links of the chain interfere with the distinct action of the weights, and it has no marked scale indicating the exact weight or rate of postage. See previous page.



The principle upon which all these contrivances are based, however, is to a very considerable extent, *fallacious*. In weighing with an ordinary balance we know that equilibrium only obtains when the scale-beam hangs horizontally, and that if it is deflected from the horizontal line, it is by the influence of some acting force; from this it

Fig. 3. ◀◀ Gabriel Riddle's elegant poise-collector, registered 10th Dec, 1839. The poises were also hidden (inside a drum), but this design is sensible because a pointer going across a graduated arc gave the postage, (8d per oz rates current from 5th Dec 1839 to 10th Jan 1840). Riddle's address was given as 'Proprietor, 172, Blackfriars Road, London', the site of his factory. Never seen, but probably made.

Fig. 4. ➢➢ The first poise-lifting design registered by Charles Griffin, of Leamington Priors, [renamed Royal Leamington Spa in 1830] Warwickshire, on 13th Feb, 1840. This design had the advantage that the cones were more obvious when they were raised, so that it was easier to ascertain the postage. Scale never seen.

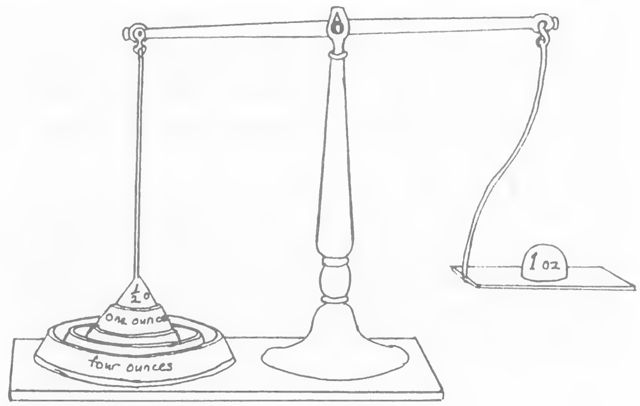
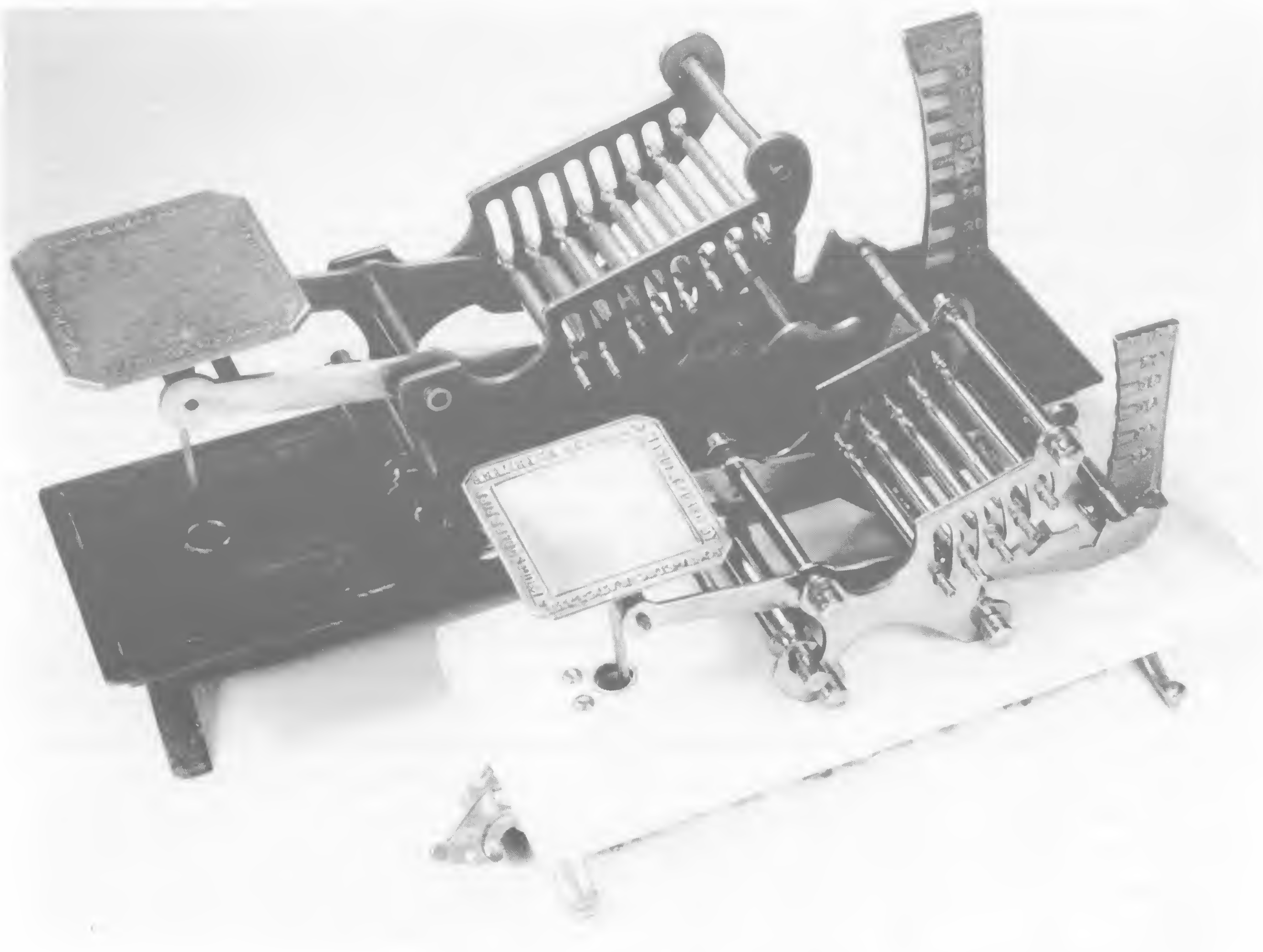
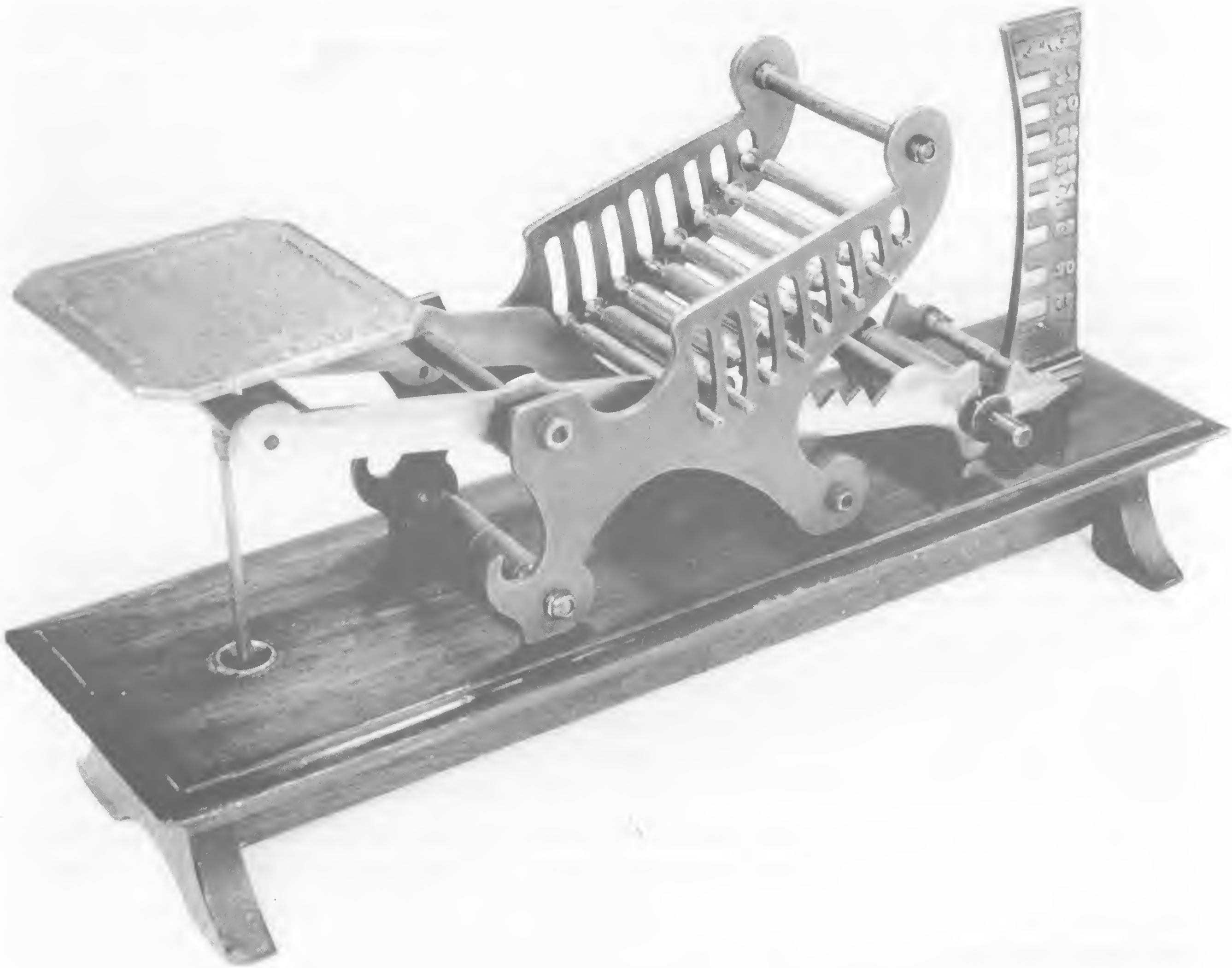


Fig. 5. ⋎⋎ Professor Willis opted for the longer protection provided by a patent, and paid the higher fee:- Patent no. 8384, of 12 Feb 1840. This confidence was obviously justified, as several versions were made during the following years. The largest version is shown at the rear, and the standard version, is at the front, with an exceptional base. (The ordinary one has a wooden base.) Two other versions, of extreme rarity, have only three poises, giving a high, squat look to the structures. Although Holtzapffel made the first example, J & E Ratcliff made the production models.



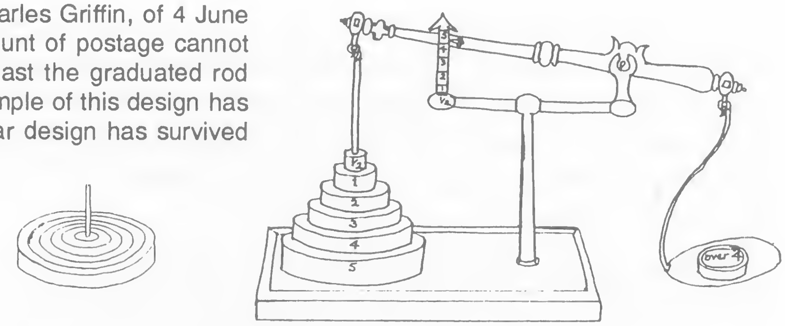
might reasonably have been inferred that every portion of the angular deviation from the true level had some positive assignable value, and was equivalent to some easily ascertained weight. The operation of this universal law goes to defeat the intentions of the several inventors before alluded to; the result being, that these balances will *not* move in definite steps- will *not* go direct from weight to weight, but with letters slightly in excess or otherwise, will vibrate, and sometimes stop between the points marking the rates of postage.[2]

Fig. 6. The criticism of Willis' design, that when adding the heavier 'additional weight' one must ignore the lowest mark and add 10d, does not apply in practice. The graduated chart is marked in pence, not ounces, so the user goes smoothly up to 10d, then adds the loose poise, reverses the scale, and reads off the back side of the chart from 12d up to 20d, that is, 10 oz. With the outsize scale below, the lower chart goes up to 16d, and the other side of the chart goes from 18 to 32d, so all letters between ½oz and 16oz are covered.



The greater the angle subtended, i.e. the greater the distance between the respective weights, the greater will be the want of certainty in action, and the matter will be rendered still worse if chains, &c., are present to increase the ambiguity of the indications. From all this it also follows, that the smaller the angle subtended by the beam, the smaller will be the interference of the disturbing influence, for which reason the invention which we are about to describe surpasses all its rivals of the "jumping" class, the objection being therein reduced to a minimum. The invention to which we allude is the patent letter-balance of Professor Willis, of Cambridge, (Figs. 5 & 6), manufactured by Messrs Holtzapffel and Co., now before us.

Fig. 7. ➢➢ The second registration of Charles Griffin, of 4 June 1840, answering the criticism that the amount of postage cannot be deduced. The passage of the beam past the graduated rod indicates the postage adequately. No example of this design has been seen, but a poise-lifter of very similar design has survived (to be shown in the next EQM).



It consists of two levers or scale-beams framed together and supported upon knife-edges; at the one end is placed a scale-pan for the reception of letters, &c., to be weighed. The other end of the lever is notched for the purpose of taking up alternately five cylindrical bar-weights which lie in a rack just above the lever at a slight inclination from the horizontal, so as to be lifted by the levers in regular succession. At the extreme end of the levers there is an index-wire pointing to an upright index or graduated scale, upon which the rates of postage are distinctly marked. When at rest the index-wire points to 1d. and the lever is weighted so as not to rise unless the letter weighs more than half an ounce, in which case the lever rises up against the first weight, the index pointing to 2d. If the letter slightly exceeds one ounce, the first weight is lifted and the lever stopped by the second, and 4d. is pointed to upon the scale. The scale extends to 5 ounces, i.e., 10d. postage; if a letter exceeds that limit, a supplementary weight is placed in the notches at the end of the lever, and 10d. has to be added to the rate of postage indicated by the machine. (In using the additional weight, it must be remembered that there is no such postage as eleven-pence: and, therefore, if the index should rest at the lowest mark, or at the second, the postage, in both cases, will be one shilling. [See caption to Fig. 6.])

The scale-pan is kept horizontal by a parallel motion, consisting of a radial lever concealed below the stand, which is jointed to a continuation downwards of the stem which carries the scale-pan.

Appended to the directions for use, is the following, which forms an apology for a defect, hardly admitted in the principle on which this machine is constructed, but which applies with greater force to the objections urged against some of its predecessors:-

"The packet should be placed gently in the scale [plate], to reduce the oscillations which are inseparable from all well-constructed weighing machines; or the balance may be held down by the index-wire, and gradually relieved after the letter is deposited, which will entirely prevent the vibrations, and prove the most rapid way of employing the instrument."[3]

The instrument before us reflects great credit on the inventor for its ingenuity and simplicity, as well as on the manufacturers for the very beautiful manner in which it has been got up. In our opinion it realises to the utmost practical extent, the principle of action upon which it is founded.

Notes and References

1 The author used the term 'weights' whereas we would use the term 'poises', no unit of weight being specified. This separation of terms is a very recent development.

2 Had the author used one of these poise-lifters? In practice, they do move obviously from one poise to the next, leaving the user in no doubt as to how much he should pay.

3 This last method is very effective, but does remove the fun of hearing the poises rattle up and down! The noise is often the clue that one is dealing with a poise-lifter.

Editor: If any of these scales are known to you, please inform the editor. Such rarities are particularly exciting!

Review

Measures and Men by Witold Kula, translated by R Szreter, Princeton University Press, 1986, ISBN 0-691-05446-0. 385pp. Out of print.

Whenever I am asked "*Why do you collect antique scales and weights?*" my reply usually contains comment on a fascination for these objects from a mechanical and aesthetic perspective but also comment on the historical, social and economic significance involved with each piece.

Finding this book seemed to fit exactly into the latter reasons for my motives. While there are no photographs or drawings and not one weight, scale, beam or balance is described in any detail in the text, the propensity to be drawn into the author's exceptional study of historical metrology and the social justice (or is that injustice?) issues involved since man first invented weights and measures is, without question, a true delight.

While the majority of the text deals with measures of length and volume this should not deter the scale and weight enthusiast, as the relativity of this study is germane to all of us. Witold Kula has researched and delved intensively into European and mainly Polish manuscripts, bibliographies, dictionaries, museum catalogues and works on historical metrology as well as the archives of many European cities. In doing so he reveals the social and economic significance of such bygone measures as the fathom, the ell, the hatchet throw and even the bull's bellow, as well as the differences in "striked" or "unstricked" grain measures, the manner of filling the measure, distance to drop the grain, heaped or unheaped and much more. The construction of measures is discussed, such as the Cracow decree of 1565 that "*The quarter and the bushell, too, shall be reinforced with iron, crosswise, both at the top and at the bottom.*"

The reader gets totally involved in the public consternation at bureaucratic attempts in 1433 by the municipal council of Gdansk to have bakers change either the weight or the price of bread to rectify poor harvest yields or otherwise-imposed fluctuations in the price of grain.

Of particular interest is Kula's discussion on the French influence towards metrication. While I and many others believed that this was simply as a direct result of the French Revolution, Kula provides a historical perspective of the hundreds of years of campaigning by reformers to influence not only French royalty but also the politicians and church hierarchy as well as feudal barons, minor prefectures and others with direct pecuniary interest in maintaining their own systems of weights and measures. The failed attempts to standardise measures is outlined by Kula with references back to the time of Charlemagne in 789 AD, up to 1789 and the activities of the post-revolutionary period providing the first stepping-stones to unite a nation with standard measures.

Kula seems particularly attracted by the French attempts in the 18th Century to get England on side as an ally to metrication and while this failed and failed again over many years he recognises a French victory with the ultimate result in the 20th Century, at the onset of the European Economic Community[1].

Kula however makes an observation that metrication was not necessarily wanted or needed by all, many ordinary people desiring to keep their national standards of measurement and weight. He makes a reference to some of the newly-independent states of the 20th Century, especially on the African continent, reverting from colonial imposed metric systems to their traditional and tribal standards of measure. This observation, if correct, needs further follow-up especially of the economic impact of those states being isolated from world trade as discussed by Kula as a benefit

of metrication, as well as the possibility of these states physically reintroducing their old weights. Perhaps it may be of no significance, given that birth notices here in Australia, 20 years after metrication, still give the weight of the baby in pounds and ounces!

Throughout the book Kula draws our attention to the misuse of weights and measures as the tools of injustice. From the time of Cain as the reputed author of weights and measures, whether measuring land or the produce of the land, we are reminded by Kula of the alteration of standard measures to suit the needs of royalty, minor nobility or even church leaders who had control of measures within their province. These leaders were entrusted with the means to protect, yet used their authority to profit over the common people. Kula provides graphic literary examples from his historical research of the legal and illegal introduction of and changes to standard measures in many parts of Europe, the attempts for reform, and the effect thereof in the social significance in the everyday lives of the people, as well as these measures being the weapons used in class struggles.

The book is divided into four parts, the first and last being general or international in content, the second part details the development of weights and measures in Poland especially related to the class struggles between the Nobility and the Bourgeoisie and the effect on the working class. The third part outlines the history in France related to the series of campaigns over a 1,000 year period to effect a unification of the French states and provinces to adopt a standardised system of weights and measures, and the eventual adoption of metrication.

As the author quotes extensively from his research, there is an impressive bibliography and record of sources, grouped by category. The many notations to the pages seems at first to be excessive; however these are grouped by chapter just before the bibliography, allowing for easy reference without interrupting the flow of the text in the main body of the book. The index seemed sufficient to me to allow cross-references for reviewing purposes.

Witold Kula has written a fascinating account of historical metrology from ancient biblical times to the modern day. It is a serious text outlining the gradual change from representational measures derived from the human body (variable but understood in each locality) to an invariable standard based (initially) on terrestrial measurements and decimal divisions.

Notwithstanding the seriousness of this study it is easy to read and to understand the compassion of the author's combination of scientific historical metrology with the social and cultural development of measures and man in an ever changing environment.

I thoroughly recommend this book to those who wish to learn more about historical metrology, the social, cultural and economic development in the use of weights and measures, some ancient and some more modern beliefs associated with measures, and the social conditions surrounding the economic development and industrialisation of Europe related to measures and man.

V Denford

(Note: The reviewers copy was discovered in 1996 in a second-hand book-shop in Melbourne, Australia at Au$20. Although initial information was that it was still in print, this appears to be incorrect in England where it is no longer available.)

Notes and References

1 Editor- a list giving the dates on which 52 countries either permitted, or made compulsory, metrication is included in *Scales and Weights* by Bruno Kisch, on page 21. This list includes Poland, where it was made compulsory in 1919.

Herbert's, Part 3

By R WILKINSON

Undoubtedly, the following extract from a letter from Jim Herbert to the Chairman of ISASC Europe will be of particular interest to those who collect Lion scales and Bankers' scales and weights; but more significantly for all of us, it encapsulates the activities and the process of integration of two of the outstanding contemporary companies through their individual experiences - as organisations operating in parallel in the same sector of business - covering 300 years. The route of their final coming-together after so long a time-scale into a single commercial enterprise, also makes his extract all the more interesting from a social-history aspect.

"The recent take-over of Vandome & Hart Ltd. by Herbert & Sons Ltd. has led to an examination of the scale trade's roots going back some 330 years and shows how the two businesses operated side by side in competition over that period.

Diana Crawforth of ISASC Europe has done a lot of research on the history of the scale trade in this country and has produced what she terms a 'Tree of Knowledge'. This records details of many of the scale-makers who formed the backbone of the trade in London from 1600, their rise and fall, partnerships formed and dissolved, families breaking up, apprentices taking over from masters, etc. and outlines the strands of knowledge and skills which have developed and been passed on over the years.

Thus, it has been from her research that we can establish that Herbert's scale-making skills were derived from a William Taylor trading in London in 1662 and then a Timothy Roberts (1693-1749). He trained a John Wood (1734-65) and it was his London business in Smithfield which, some four generations later, was acquired by Thomas Herbert in 1869 - Thomas had got his training with Palletts who he joined as a boy in about 1826 before setting up on his own. It is from this association that we claim 'Established 1760', although Woods' letterheading clearly reads 1740. Herbert & Sons Ltd. moved to Haverhill in Suffolk in 1968 and have been operating for five generations, now in the hands of our Managing Director, Richard Herbert.

Vandome & Hart Ltd. trace their beginning from the 1670s when a Samuel Freeman, a scale-maker operating from Leadenhall Street, London, supplied scales to the Bank of England, and this business was taken over by William New in about 1780. A Richard Vandome of a Huguenot family came from France in 1782, served his apprenticeship with New, and subsequently took over this business. His name first appears in the London Directory of 1806. On his death his nephew, William Titford, proceeded to take control and that family continued with the business until 1962, during which time they had amalgamated with the scale-makers, David Hart & Co.

Vandome & Hart continued to trade as a private company without family connections until 1995 when it was taken over by Herbert & Sons Ltd."

Referring to the trade-card of T Hamshaw, (EQM p 2110) Jim Herbert has records showing that Herbert's bought Hamshaw's in 1914. He also has a rough sketch of the shop in Feathers Court of Hubbard and Walker, London scalemakers who were established in 1820, and acquired by Herbert & Sons Ltd in 1919. [Editor:- Due to shortage of space in this issue, it is not shown.]

Further reading

'Herbert's, the Tale of a Lion', published in EQM, p 1192-1202, by A James Herbert C.B.E., ISASC Europe Member and formerly one of our Trustees, and the former Chairman of Herbert & Sons The article describes details of his Company and its products.

For 'Herbert's, Part 2', (A Chronology of Trade Scale-makers), by Diana Crawforth-Hitchins, see EQM pages 1723-48.

See p 2090 for the trade card of their predecessor, Richard Wood.

Response to Bussey Questions

BY S van BEEK

Yet again, there is a misunderstanding about the Salter use of the Staffordshire knot. Just because a spring balance has not got the knot stamped on to it, that does not mean that it had to be made before 1884. After this date, many balance of various models were made by Salter without their trademark. The only conclusion that can be drawn is that a Salter balance *with* the knot had to be made after 1884.

When requested by an important customer, Salter's could put the customer's name on the dial, sometimes with Salter on the dial too but without the trademark, and sometimes with the trademark but without Salter's name. See EQM, p 523, fig. 23, for an example of Salter's making for W & T Avery. In England, putting the name of the dealer on the balance was mutually agreeable to both Salter and the dealer, but it was different abroad. Take Germany as an example. Salter was unknown and it was inconceivable that foreign balances might be of better quality than German balances. So Salter balances were marketed under the name of the assembler or the name of a well-known retailer, without the Salter trademark, more or less pretending that these balances were a German product. For example, Krups retailed Salter letter balances, with Krups snake-and-arrow trade-mark and "LETTER SALTER" with the rates of postage for Germany c.1930. Strangely enough, words on the dial such as Spring Balance, Circular Balance or Letter Balance were not translated. See EQM p 1440 for examples from E Ubrig's catalogue of 1892.

In respect of the Bussey shown on p 2087, I am fairly confident that the No. 2 balance and its springs were made by Salter, and that Bussey was just one of the London dealers. Moreover, No. 2 is a balance designed by Salter in 1870 and imprinted for the first time on the dial in 1898, to indicate that it was the second quality of their circular balances, pattern No. 60. Pattern No. 2 balance was a pocket type of balance, although it was too large to go literally into a pocket, being 16 inches (400 mm) long. So, unfortunately, we must conclude that the balance illustrated was *not* made before 1884.

I believe that the same arguments hold good in relation to the Parcel balance shown on p 2088. With this kind of brass pan and frame, it is mostly referred to as a Letter Balance. With regard to the patent, Salter warranted the design, including the special springs for this kind of hanging balance, in 1838. The patent refers to the flat dial and the pointer in a tubular balance (instead of the sub-divisions being marked on the steel rod that was pulled out of the casing of the balance.)

The Bussey patent of 22 January, 1879, on p 2087, refers to an improvement of a spiral spring of any shape, size or strength, suitable for many purposes, to be pulled on at both ends in opposite directions. This has nothing to do with Salter's, as their springs for balances were designed specially, and made out of special steel, suitable for each weigher. This is in contra-distinction to German scale manufacturers, who generally bought in cheap, general-purpose springs, not being spring manufacturers themselves. Thus, Salter products specifically were acknowledged by many governments, since 1907, and got approval from Weights and Measures Departments world-wide (the only company to be so trusted).

The spring is always fixed to the top of Salter weighing mechanisms, while the lower end moves down by the load applied, with no pulling on both ends! Technical and economic reasons argue against Bussey's applying his system in Salter spring balances.

I do agree with Mr. Moon that the Parcel/letter balance (p 2088) dates from before 1883. Postal rates were introduced in England in December 1839, but I do not know exactly when Salter started to put those rates onto the dial, although I believe it was before 1870.

With respect to the balance illustrated on page 2089, I can add that only after 1844 did Salter put on the dial "Improved (circular) Spring Balance". "Improved" referred to the fact that Salter applied tension springs instead of compression springs, and to the fact that to a certain degree, a rack and pinion were applied to a hanging balance. Of course, this particular balance was made well after 1844.

After the invention of a rack and pinion mechanism in 1820[1], Salter introduced standing weighing machines with round dials, while, as mentioned above, in 1838, flat dials were fixed to slide balances.

1. Editor: The rack and pinion was used by other makers before 1820. Perhaps it should say 'After the adoption...'

Angldile Computing Scales, Part 1

BY J & W BERNING, L NOSAL, T STEIN, G A & P WEHMAN, J WILEY and R WILLARD

Price-indicating scales

Price-indicating scales are the inheritors of the 18th century dials or part-dials showing the various units of weight (as on the scales of Anscheutz and Schlaff, EQM 1851, and Hanin, EQM 1866,) and also the various mechanisms showing the cost of postage per ounce, beginning in the mid-19th century, EQM, 395 on, and this issue, 2122-26. The earliest American patent, granted to the Computing Scale Co., of Dayton, Ohio, on March 31, 1888, was a complex quadruple-beam platform scale that gave the weight and price in two separate operations. Price-indicating scales became increasingly popular during the next two decades as several other scale-makers were granted US patents. See Part 2 for other patents for grocers' and confectioners' pricing scales.

Of all these mechanisms, the Angldile is one of the most original designs and the history of that company reflects the turmoil of the Progressive Era, when fortunes were made and lost as the government began asserting its authority in the areas of industrial and business practices, natural resources and social welfare.

A Family-owned, Family-run Business

The Angldile Computing Scale, one of America's most distinctive weighing machines, grew out of a chance conversation between a young ranch-hand from Nebraska and an unidentified man *who knew something about computing scales*. Afire with inspiration, J Edward Cochran pulled up stakes and headed for the Chicago area to develop his dream of inventing the world's finest computing scale.

Fig. 1. ▽▽ **Why the peculiar name?** In their advertisements, Angldile scales are shown directly from the front, so that the conventional dial, indicating the weight of the load, is obvious. Only when seen from the rear does it become apparent. At the rear is a cone, concealing a rotating cone covered in numbers. The inner cone is rotated by the load, and can be seen rotating by the merchant through a long slot at an angle to his view-point.

Photo P Wehman

To quote the booklet B supplied to buyers of Angldile scales :

The name is intended to tell you first off that the dial on which the merchant reads is set at an angle of 45 degrees. You are holding this book at that angle right now, because it is the natural angle at which we read a book or paper.

Quote from catalogue A ➢:

This model, the 21G, enamelled in gold-bronze with 14 carat gold-plated trim, has a dash-pot to the left of the dial. See other US candy scales, EQM, p 2097-2102.

As a result of this angle the Angldile is read alike by all persons. In order to read a barrel shaped scale's chart correctly, it is necessary that the eye of the operator shall be exactly horizontal to the price lines that are to be read or counted. It therefore follows that tall or short clerks always get different readings on scales of that sort, unless they adopt unnatural attitudes.

Equal care must be taken in reading the chart on the fan shaped computing scales. It is necessary for the operator to place himself so that his eye will be in an exact line with the pointer on such a scale, and the proper figure or mark to be read. Unless he moves with the pointer, he will get an incorrect reading, because his eye will be in line with a mark at the side of the one which should be read. Under such conditions, either the store or the customer must get the worst of it.

With the Angldile no such mistake is possible, because the dial is held at the natural angle to be read correctly by all persons, and is read without moving from the position in which you stand in placing the goods upon the scale.

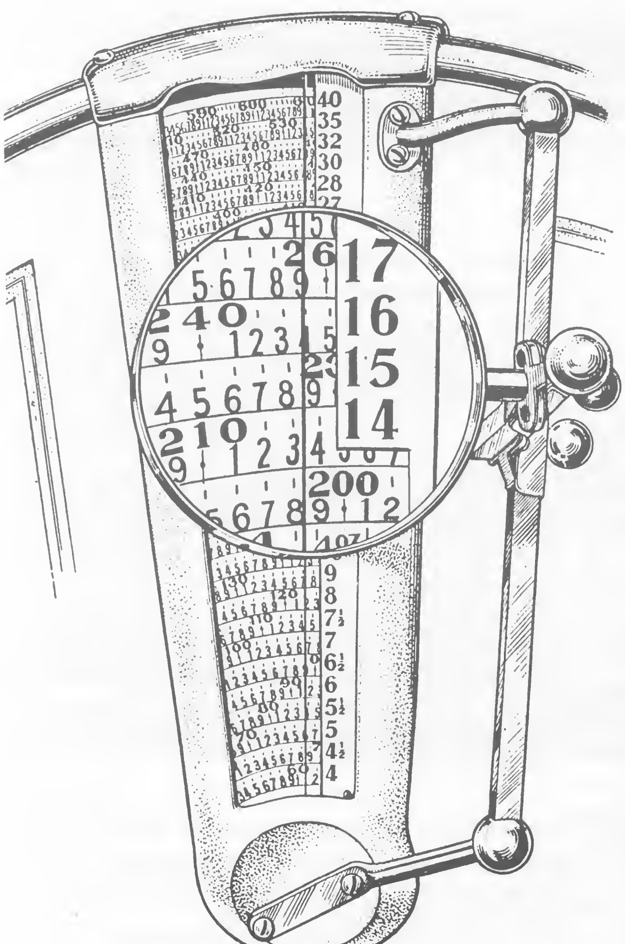
Fig. 2. ➤➤ **Computing** Most computing scales have a dial and pointer, permitting the merchant to run his finger up the pointer or fiducial edge, once it stops turning, to the circle dealing with the relevant cost per oz. (or per lb) and then read off the exact cost.

However, on the Angldile, the cone-shaped dial rotates until the pendulum is in equilibrium, then remains stationary, with a strip of numbers showing. The merchant runs his finger up the right-hand edge until he gets to the price in cents per pound that he is to charge, and then he looks along the line to the left until he gets to a large number (say, 240) then he moves his eyes back towards the right until he has gone as far to the right as the window permits, adding on all individual cents shown, (say 5) and reaches the cost of the load at 245 cents. The customer can see the weight, the shop-keeper says 'Okay at $2.45?' and the bargain is struck. The merchant knows the weight of the load by reading the stripe half way down his window (see below).

This is the smallest Angldile scale made, the 21G, with a foot out to the rear, (an addition to the original design), seen on some examples. All the other Angldile scales in catalogue A had a lever arm out to the side, supporting the load pan, (discussed in caption to Fig. 9).

Photo P Wehman

Fig. 3. **Reverse view**
View the customer got of the prices in the mirror. ➤➤
The mirror is shown very clearly in Figs. 8 & 12.



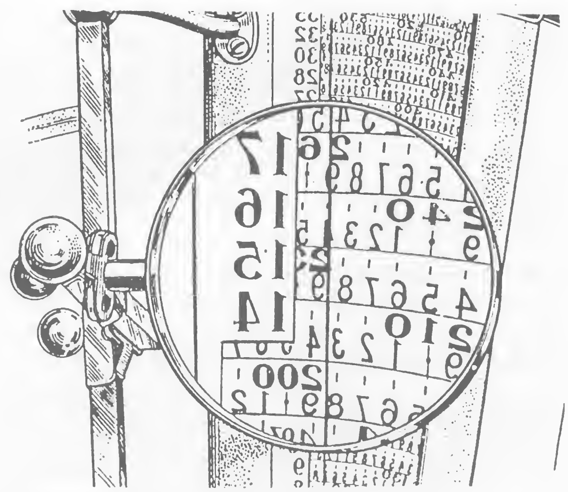


Fig. 4. ⋞⋞ The rear dial of the larger 303R, capacity 30 lb, showing the 'window' through which the merchant reads the price, with the extra lens, the 'Adjustable Reading Glass', that short-sighted merchants could buy. No mention is made of the obstruction caused by this Reading Glass to the customer attempting to read the price in the reflector (shown in Figs. 8 & 12) provided for his use.

The chart shows distinctly that up to 8 oz, the price is indicated in ½ cent increments, and every cost is indicated separately, as advertised. However, above 18 oz, some prices are omitted, the missing ones being 19, 21, 24, 26, 29, 31, 33, 34, 36, 37, 38 and 39 cents per lb. (See Fig. 6.) So, the claim to indicate 'all prices per pound' is not correct. What did the merchant do if the price was one of those omitted? Perhaps he was expected to look at the price below the one he wanted and at the price above, subtract the lower from the higher and divide by the number of prices omitted, and add that total to the lower price. It would work if he was good with numbers!

Fig. 5. The catalogue A makes exaggerated claims for the chart and is worth quoting in full: ⋎⋎

> This price is not indicated by a system of hair lines or small dots which have to be counted by the merchant. Instead of such old-fashioned, inaccurate methods, the merchant 'reads' *A Plain Figure For Every Penny's Value* in larger, clearer characters than you are now reading In this most important detail, the Angldile differs from all other scales ever made for counter purposes.
>
> It does better work than any other scale by reason of its cone-shaped chart, which is a marked improvement over all other forms of charts yet produced. Only by means of a cone-shaped chart - for which we own the exclusive patents - is it possible to secure the correct spacing necessary for all prices per pound.
>
> A cylinder or barrel-shaped chart, for instance, is just as large at one end as at the other. It has plenty of room at one end for the figures needed to show the price of articles sold at the lower rates per pound. But at the other end, where much more room is required, the barrel or cylinder-shaped chart is deficient. At the highest prices per pound, where accuracy is of greatest importance, the figures - or lines which represent them - are closely crowded.
>
> It is therefore necessary, with such scales, to abandon half of the lines when the higher prices are reached, and computations are then made by 2c jumps.
>
> A fan-shaped scale has even greater faults and deficiencies than a barrel-shaped scale. The fan can show only a portion of a circle and the space for figures is therefore smaller than is possible on a cylinder-shaped chart.
>
> As compared with a fan-shaped scale, the Angldile has practically as much space as would equal the complete circle of which the fan-shaped chart is a part.

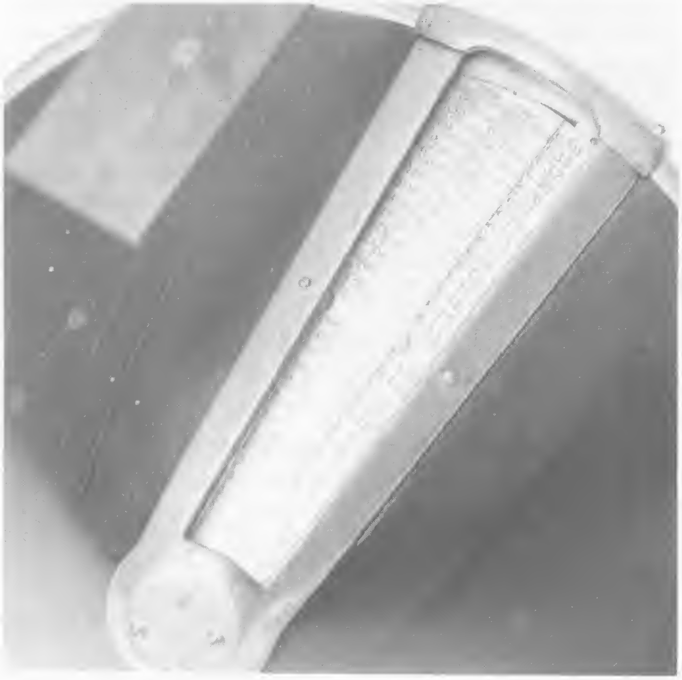


Fig. 6. ⋏⋏ The chart of the 303 R, with nickelled trim. There are 20 lb on the chart and 10 lbs on the tare-beam, (see Fig. 9). This one is dark red enamel and black with gold trim. The reflector for the customer to see the prices is visible at top left. The band across the middle tells the load's weight Photo P Wehman

Fig. 7. ⪢ bottom, Electrification

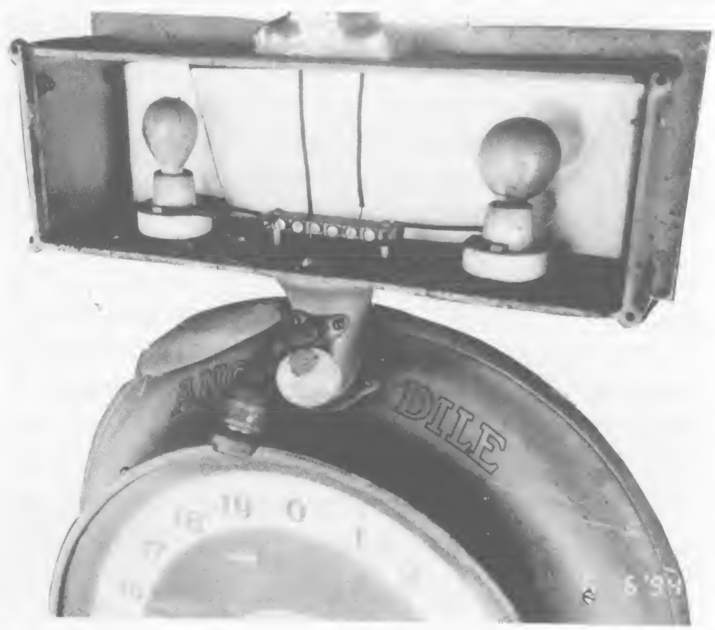
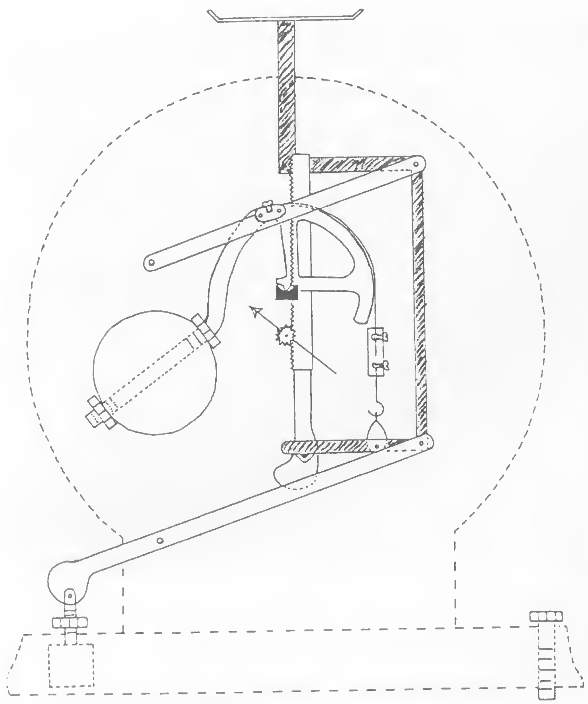


Photo L Nosal

This scale, an adaption of Model 303, capitalised on the increasing electrification of American culture. Purchasers and bystanders too enjoyed watching the scale light up when a load was placed on the pan. No doubt they sometimes made several separate purchases, just to watch the lights come on. The box-like marquee, made of pot-metal with opaque glass back and front panels, contains two light-bulbs. The merchant could write on the glass using a grease pen, perhaps at the front telling his customers of his best offers, and at the back, jotting down things he needed to order.

Another socket, angled out below the marquee, held a bulb to light the dial. The customer was protected from the glare by a hemispherical brass shade (not shown). On the merchant's side, the usual reflector is replaced by a long tubular bulb that lights the computing chart. Power was originally brought to the marquee through the porcelain fitting at the centre top, which could be connected to a light-socket hanging from the ceiling. In later years, the two wires (visible in the photo) were threaded down inside the drum to a cord that plugged into a wall-socket. This massive scaleismodel 303BE, (30 lb capacity, style 3, blue, electrified).



Drawing by P Wehman

Fig. 8. << **The mechanism** The shaded rod descending from the load pan is a rigid rod angled to the right, down and to the left, and is held in position by the parallel linkage shown as two diagonal arms, linked on their right to the push-down rod, and attached on their left to the casing. The lower parallel link has an extension beyond its fixing, to the dash-pot, which reduces oscillations. The bottom of the push-down rod bears down on the rachet, which then turns the centre cog attached to the pointer and the cone-chart. The push-down rod is also attached to a flexure riband that goes up and over the quadrant, so that when the push-down rod descends, the quadrant is turned clockwise, pulling the counterpoise up until equilibrium is reached. The customers enjoyed the movement, so Cochran used a clear glass dial on some versions.

The larger versions operate in the same way, but with an additional lever arm out to the side that pulls the strap down. The load pan presses down on that lever arm, on steel knives working on Siberian agates. Angldile claimed *There is practically no wear to the Angldile scale bearings because there are no irregularities either in the knife blades or the agates.* The mass of the lever arm is counterbalanced by a box beyond the fulcrum which is loaded with shot.

The cone has a set of bearings at the point and a set near the poise, to take the weight of the heavy cone. In the 5 lb capacity, 52-GO, Joe Wiley found the remnants of spindle bearings, which he replaced (by some clever lateral thinking), by using the brass inserts from several ball-point pens! Leonard Nosal's 303-BE, 30 lb capacity, proved to have ball-bearings rather than spindles[1].

Cochran's first two years in the scale business must have seemed less a dream than a nightmare. Setting up a factory in Dundee, Ill. in 1904, he spent nearly a year developing his invention and securing his first patent, while at the same time attempting to learn the scale business. In 1905 he moved the establishment to West Pullman, Ill. There he spent another year securing two more patents and trying to convince others of the merits of his scale. But although functional, it was crude and unattractive, and sales were few and far between. Cochran later related that the only time his firm got any mention in the newspapers was when the Pullman factory burned to the ground, leaving the young company with only a few surviving tools, nary a dollar in incoming accounts, and in fact, nearly destitute. He began looking for a new location.

About then, one Herbert E Bucklen of Elkhart, Ind. appeared on the scene. He must have been a builder, a civic booster or a scales buff, and perhaps all three! Elkhart, he said, was becoming a centre for light industries. The city would welcome a new scale company, and he just happened to own a vacant building suitable for a factory. That same year, Bucklen helped organise the Strubler Computing Scale Company in the old wrench factory in Elkhart, confirming his enthusiasm for scale companies, and providing severe competition for Cochran, as the scales of the two companies were intended for the same customers:- shop-keepers weighing loads between 2lb and 30 lbs.

Details are scanty, but in November 1906 J Edward Cochran and his brother Percy moved to Elkhart, Ind. where, with the backing of their father, Joseph W Cochran, they opened a factory on East Franklin Street. See EQM, p 180 for an excellent picture of the factory[2]. Little more is heard of Percy, but J Edward worked unstintingly for the success of his idea. Although his title was General Manager, he worked in the office and in the factory. On one occasion, when a picture was taken of the employees, he donned overalls and coat and posed as a workman in order to make the workforce look larger. In the first six months, the equipment was installed and the staff sufficiently trained to produce 100 of the

original models[3]. In June 1907 the firm introduced the conical computing chart that was to make the company famous. Additional patents were secured in 1908 and 1909.

Table 1		Models made by Angldile				
Model No.	Capacity of Chart	Capacity Tare-beam	Position of load	Chart No.	Price range per pound on Chart	Date
21	2 lb	No beam	Top	1 (5½" wide)	10c to $1.00	?
52	5 lb	No beam	At side	2 (5½" wide)	5c to $1.00	Patent 1909 Still made after 1926.
203	20 lb	No beam	At side	3	4c to 40c	?
203	10 lb	10 lb	At side	3 (11" wide)	10c to 80c	?
204	10 lb	10 lb	At side	4 (11" wide)	?	?
303	20 lb	10 lb	At side	3	4c to 40c	Patent 12.13.1904 Pat. pend of 1908 & 1909, so made c 1909. W & M Seal 1954
305	20 lb	10 lb	At side	5	10c to 40 c	?
Tare Scale[4]	20 lb	No beam	At side	Not known	Not known	?
Not in catalogue A	15 lb	10 lb	At side	Not known	Not known	?

The Angldile is different from nearly every other scale in both appearance and mechanism. Its nickname, *the scale with the cone and the angle* derives from its two most visible features. The dial, 11¼ inches (290mm) in diameter, was the largest one made, and the computing chart was the only one positioned at an angle that enabled persons of varying heights to get an accurate reading, and the only one having a clearly legible figure for every penny. (This claim by the company is disputed in the captions to figures 4 and 5.) The scale was advertised as being made in the capacities of 2, 5, 20 and 30 pounds, and several designs, some having lighted marquees [decorative "caps" on top of the scale], dials and computing charts.

Photo P Wehman

Fig. 9. **Tare Beam**

Angldile offered a 30 lb capacity model 303 by the strange means of adding a tare-beam to a 20 lb capacity scale, instead of increasing the mass of the resistant (the poise of the pendulum) to balance against a 30 lb load.

As shown on Table 1, they used the same method on the model no. 203 to expand capacity from 10 lb to 20 lb.

The beam seems to function in this way:- For any load under the capacity of the chart alone, just use the chart to get the price, as described in Fig. 2.

For heavier loads, first put the slide on the tare-beam to 10, which subtracts 10 lb from the chart. Then apply the load, and look up the price on the chart, and add to it ten times the price per pound.

For example, on the 303, suppose the customer wants 24 lb of goods valued at 12c per pound. Move poise to 10 lb on the tare-beam, add the 24 lb load, find the chart is reading at 14 lb, and indicating 168c, add to that 120c for the value of the 10 lb on the beam, and the total cost is 288c or $2.88.

Fig. 10. **Taring with large load**

When a customer wants a load beyond the capacity of the chart alone, and that load has to be weighed out in a container, the merchant has to keep an even clearer head, and avoid talking to the customer during the operation!

Suppose the customer wants 24 lb of goods at 12 c per pound, and the container weighs 1 lb 7¾ oz (but the merchant does not know, or care, what the container weighs.)

The merchant puts the container on the pan and slides the poise along to re-set the reading on the chart ribbon to zero pounds. Then he puts 5 lbs of goods in the container, using the ribbon for guidance. He reads off the cost of the load on the chart, at 60c. He writes that down. He re-sets the tare bar, using the poise, to read zero pounds on the ribbon on the chart. He calculates that the customer wants another 19 lb, so he adds 19 lb to the load in the container, using the ribbon again for guidance. He reads the price of the 19 lb on the chart at 228c. He adds that to the 60c he wrote down earlier, and gets the total of 288c or $2.88 for the customer to pay.

Photo L Nosal

In 1909 the company was incorporated with a capitalisation of $300,000[5]. Angldile scales were being sold all over the United States. Large shipments to distant cities were a daily occurrence. The scale had been exhibited at several expositions and received the grand prize at the Alaska-Seattle fair in 1909. In 1911, having out-grown its quarters, the business moved to a spacious plant especially erected for it on Elkhart Avenue by C G Conn, the well-known maker of band instruments. Additional products were developed: coffee mills, meat grinders and an automatic packaging machine. Export marketing commenced. The Angldile Scale Company had become one of Elkhart's outstanding enterprises.

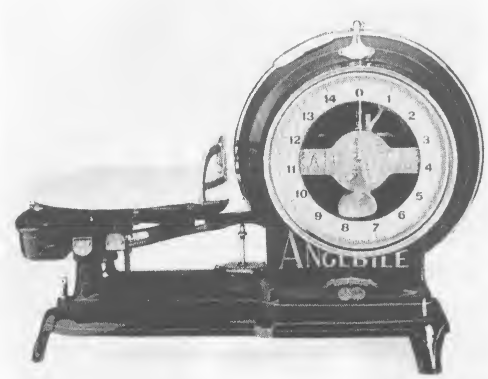
Fig. 11. **Rugged Construction**

Even the smaller versions were very robustly made of cast-iron. With the foot underneath the basic machine, the whole thing can only be moved by a strong man.

The stand on this rare model (not in the catalogue A) is 26 ins (650 mm) long. It is interesting that the catalogue makes no mention of the great weight involved for shipping, whereas many other companies specified the weight and dimensions, so that the customer could calculate the shipping costs. Does this mean that all Angldiles were sold by a salesman who dealt with shipping matters verbally?

Did he, at the same time, tell the potential buyer the cost of each machine? The catalogue does not give the price.

This is the 15 lb version with 10 lb tare-beam. Only two examples known.



Owner T Stein

Absentee Ownership

But the firm may have expanded too rapidly for its resources. The front page of the *Elkhart Truth* of 28 April 1914[6] announced that a group of Pittsburgh, Pa. businessmen *backed by unlimited capital* had bought all the assets (but none of the liabilities) of the company from the estate of Joseph W Cochran, a millionaire lumberman who had recently passed away. The new organisation planned to double the workforce, triple the output and launch an aggressive sales campaign, both domestic and export. After increasing the firm's capitalisation to $500,000 the new owners announced, perhaps prophetically, that the finances were now *beyond the needs of the company for the next three years.*

Photo P Wehman

Fig. 12. **Extras**
The basic machine could be supplied with several additions. Fig. 2 mentions the stabilising foot.

Fig. 4 shows the magnifying lens that was offered, although none is known to have survived. Fig. 7 shows the light-up marquee that could be added. A plain marquee was available or a very ornate one.

Fig. 9 shows the pot plate, but they also offered glass plates, 9 different scoops, enamelled fish-pan & 4 different pans. Because of the great range of pans, the balancing box was an essential component, adjusting the beam pressure on the flexure riband.

Fig. 10 shows the rest decorated with an 'A', but other versions were available. Fig. 11 shows the clear glass dial on the customer's side, allowing a view of the mechanism, but this photo shows the opaque glass version. Fig. 11 shows the stand. This photo shows, particularly clearly, the dash-pot (damper), and the spirit-level to its left.

As with all pendulum scales, it was essential to set the machine level before use, and not to move the machine after the screw-feet had been corrected (not that anyone would, with such a heavy machine!).

The enamelled finish came in Gold-Bronze with gold trim;
Blue (robin's egg) with nickel trim.
Red (dark) with nickel trim, all offered in the catalogue A.
The nickel plating was applied to bezels, name plates, patent-plates, end-plates, dash-pot, etc.
But examples are known in Maroon with black and gold trim;
Robin's egg blue with black and gold trim.

The inscription on the dial of this heavy-duty 303 reveals its age: *Pat. 12/13/04, Other Pats Pending*. So it was made before the 1909 patent was granted. The State of Illinois sealer's sticker of 1954 on the glass reveals that it was in use for a long time. This is the example, quoted above, in maroon with black and gold trim, with floral decoration.

The sale was arranged by S A Horner, general sales-manager of the old company, who, as a vice-president of the new company, would remain in Elkhart to run the business. The executive offices would be located in Pittsburgh, 370 miles away. The estate would retain some stock in the new firm, but the Cochrans had retired from active participation. It was reported that J E Cochran, who had been in full charge, would leave Elkhart. It had been almost exactly ten years since he opened his first factory.

Various Polk Directories for the city of Elkhart reveal the chilling accuracy of the purchasers' financial projections. The 1914 directory lists the Angldile Computing Scale Co. and also its officers, including S A Horner, vice-president. Three years later, the 1917 directory contains no

listing for the once-proud firm, although J G Sims, a former field sales-agent who had come from Memphis to manage the plant for the Cochrans, is listed at his residence with the occupation "*manager*".

Receivership, Rebuilding and Resale

What happened? Almost immediately after Sims was named plant-manager the firm was sold, new management installed and the executive office moved to Pittsburgh Pa. An advertisement of 1915 claimed a daily production capacity of 75 scales and 10 coffee mills[7]. They exhibited at the 1915 Panama-Pacific Exposition, according to their trade-card. But in 1918, for reasons not known at present, the company was placed in receivership. Sims, obviously, was a survivor. Mindful of the old adage, "*When life deals you a lemon, make lemonade!*" he somehow managed to buy the assets of the company for about ten cents on the dollar at the receiver's sale, and then set to work rebuilding the Angldile company, at first in part of the Elkhart Avenue plant and later in part of a 30 year old building at 927 Plum Street. Coincidentally, the Plum Street factory was built by Herbert E Bucklen for the Stimpson Scale Company, which he helped to organize. (Stimpson had later moved to Detroit).

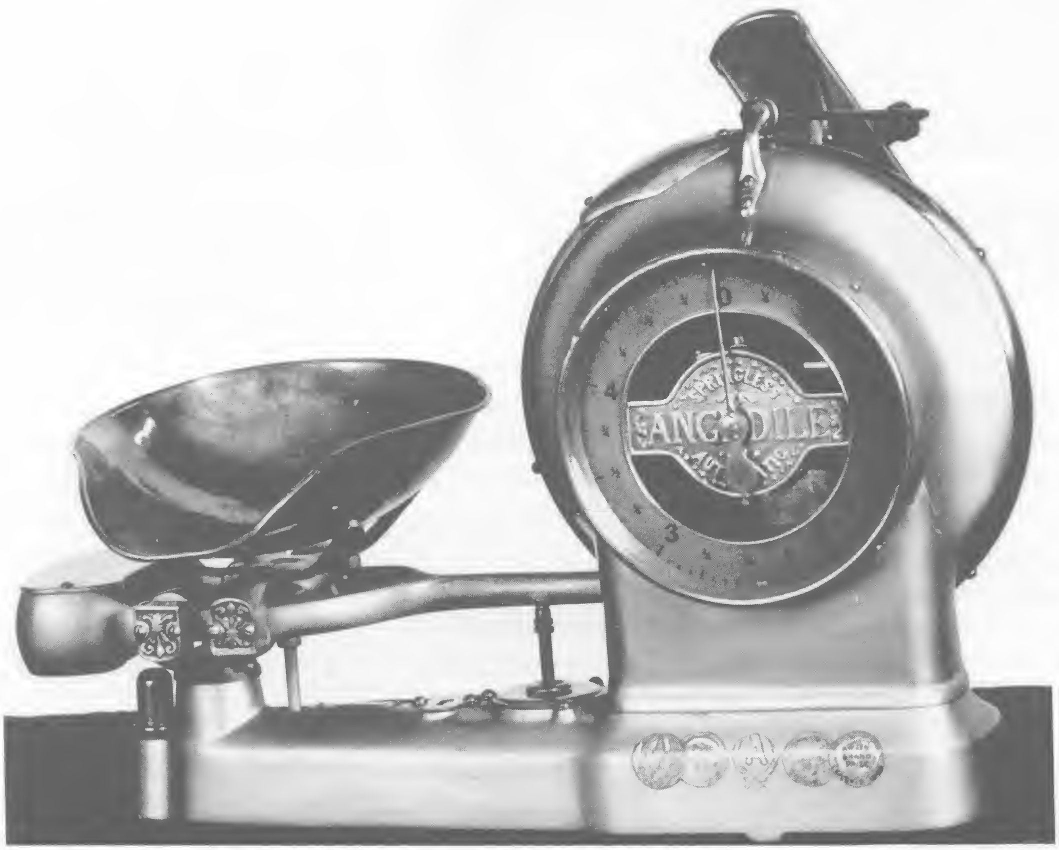


Fig.13. ᗅᗅ Photo J Wiley

This 52 GO, with 5 lb capacity, is for more expensive items, bought in smaller quantities. It has the gold-bronze finish and the open dial showing the interior mechanism, which is plated with 14 carat gold through-out.

As no patents are referred to, it was probably made after the patents had expired, the last patent being taken out in 1909, so this scale was probably made 1926 or later (after the 17 year patent protection had expired). The medallions are very worn, and almost illegible. The Alaska-Seattle fair's medal of 1909 is just visible.

Joe Wiley bought this scale in 1986 as a box of pieces from a dealer who told him that the scale came from the Blue Bird Candy Store, where Joe first met his wife, Retha, in 1940.

The 1920 Polk's Directory lists the Angldile Scale Company, 912-927 Plum, incorporated January 1, 1919, with a capitalisation of $50,000. John G Sims was the president, Carrie K Sims, his wife, the vice-president and C C McJunkin, secretary and treasurer. But not for long. On the front page of the Elkhart Truth dated September 18, 1925[8], Sims announced his sale of the company to the Smith Scale Company of 265 West Spring Street, Colombus, Ohio. All of the Angldile machinery and equipment was to be moved to the Columbus factory, 250 miles south-east of Elkhart, with the dismantling to begin early the next week. Sims expected the machinery to fill at least three freight cars.

The Smith Scale Company

As described by Sims, the Smith Scale Company was in a good position to market Angldile scales. *The company was organized in July 1916, for the purpose of making scales under patents of Walter Standish Smith, who has had long experience with all types of scales*" he said. "*They are makers of the Exact Weight non-computing scales in a wide range of models that are used in nearly every line of business by manufacturers and retailers. The combination of exact weight scales, for predetermined weights, with computing scales that show money values as well as accurate weights will give the Smith Scale Co. a particularly strong position in the mercantile world.....It is the expectation of the Smith Scale Co. to extend services to all users of Angldile Scales.*

What of Sims' future? Within eleven years, he had been a successful field sales manager, plant manager of a firm that went bankrupt, purchaser of its assets and owner and seller of the rehabilitated firm. Firstly, he and Mrs. Sims planned a vacation trip by car to Richmond, Va. (Only one who has travelled that many miles on 1925 roads in a car of that era during the month of October can possibly grasp the implications of such a trip.) On November 1, presumably refreshed and rested from his vacation, he was to assume his new duties as sales manager for the Smith Scale Company.

What happened next?

What of the Smith Scale Company? At some point. they probably took the name of their products Exact Weight Scales as their company name. How long did they manufacture Angldile scales? Why did the Angldile fall out of favour? Who has looked up the patents of Walter Standish Smith? What became of the Exact Weight Scale Company?

What happened to the Strubler Computing Scale Company? As the makers of conventional fan scales in 2 to 30 pound capacities, they had to fight for a share of the market. According to a 1916 county history[9], they had vacated their original quarters on Crawford Street and erected a new plant near Elm, so were, presumably, confident of a decent market share. Has any reader seen a Strubler scale?

What became of the Stimpson Computing Scale Company? When last heard of, they had headquarters in Detroit. What scales did they make, and during what time-period? Did they merge with any other company?

Editor: For tips on researching American scale companies, see Doniger, EQM p 2048-49, Mallis p 2059-2066 and Willard EQM p 2096. Let us hear from you!

Notes and References

1 Ball-bearings were used by W & T Avery Ltd in a price-indicating scale that they submitted to the Board of Trade in Nov, 1937. The scale had a top pan over a pendulum unit, with a drum-chart! It *looked* modern, but the ideas were mature! (With thanks to John Cheeseman for finding this information.)

2 Postcard owned by N Sturgess.

3 Has any member any information, photos, drawings, etc, of these pre-cone Angldiles?

4 The tare scale is advertised in catalogue A, but no example has been seen. The description is being withheld to use in an article about tare scales.

5 *Elkhart, 1910, A complete and comprehensive description of the city of Elkhart, Indiana.* Truth Publishing Co. p 26-27.

6 *Elkhart Truth* (daily newspaper) for April 28, 1914, p 1.

MacMillan, *Index to Coffee Mills*, 1995, cf. Angldile Scale Co.

7 *Elkhart Truth*, Forward Edition, June, 1915.

8 *Elkhart Truth*, Sept 18, 1925

9 Weaver, A, ed., *A Standard History of Elkhart County Indiana*, Chicago and New York: The American Historical Society, **1**, 1916, p 373.

Additional Material Used

Angldile catalogue A. Not dated, but printed between 1911 and 1918, judging by their factory location.

Angldile Salesman's Handbook...

Fieldhouse Charles, *For Land's Sake.* Elkhart Service Press, 1957, p 135.

Old Advert, 1920

Polk City Directory for Elkhart, 1914, p 32, 166, 240.
1917, p 552.
1920, p 29 and 511.
1922, p 194.

Editor:- 'Angldile's competition in Price-indicating Scales', part 2 of this article, will be in the next EQM.

Authors' biographies

Jan and Bill Berning, who met at the Chicago ISASC convention, celebrated their first wedding anniversary at the San Diego convention in 1992. Professionally, they deal in coin-operated scales, which they repair, restore, sell and operate. Bill is co-researcher with Dick Bueschel on *Big Head Lollipop Scales*, the definitive work on coin-operated scales (to be reviewed in EQM soon). With Jan, they are currently working on two more books, using their large, eclectic collections for inspiration. Jan has, since her time living in Germany, demonstrated a real gift for finding exceptionally rare scales. Letters from the Bernings always bear a lot of historic 1930s, 1940s and 1950s postage stamps in 2, 3 and 4 cent denominations.

Leonard Nosal, a dentist by profession, came into scale collecting indirectly by way of his interest in country store collectibles, especially cash-registers. He specialises in grocery-store counter scales with emphasis on computing scales. He dismantles and rebuilds every scale, and generously shares his knowledge with ISASC members. He supplied most of the historical background for this article.

Ted Stein takes special pleasure in the aesthetic qualities of his scales. To that end, unlike most collectors, he restores and refinishes all his favourite finds to look like new. He specialises in counter scales and mint scales, so he is not in competition with his brother, Bob, but can share the family enthusiasm for antiques.

George Anna and Phil Wehman's biographical sketch is on EQM, p 2100. They are frequent and very generous contributors, endlessly patient in dealing with questions arising from their special knowledge.

Joe Wiley, a retired accountant who always wanted to work as a mechanic, finds special joy in disassembling and rebuilding all his scales, and in comparing notes with other collectors. He also restores classic cars and paints portraits and landscapes, working both in oils and acrylics. His wife, Retha, comes to every convention, just a full of enthusiasm as Joe.

Ruth Willard's biographical sketch is on EQM p 2053. Needless to say, this article would not have appeared without the investigative and collating skills of Ruth.

ISASC

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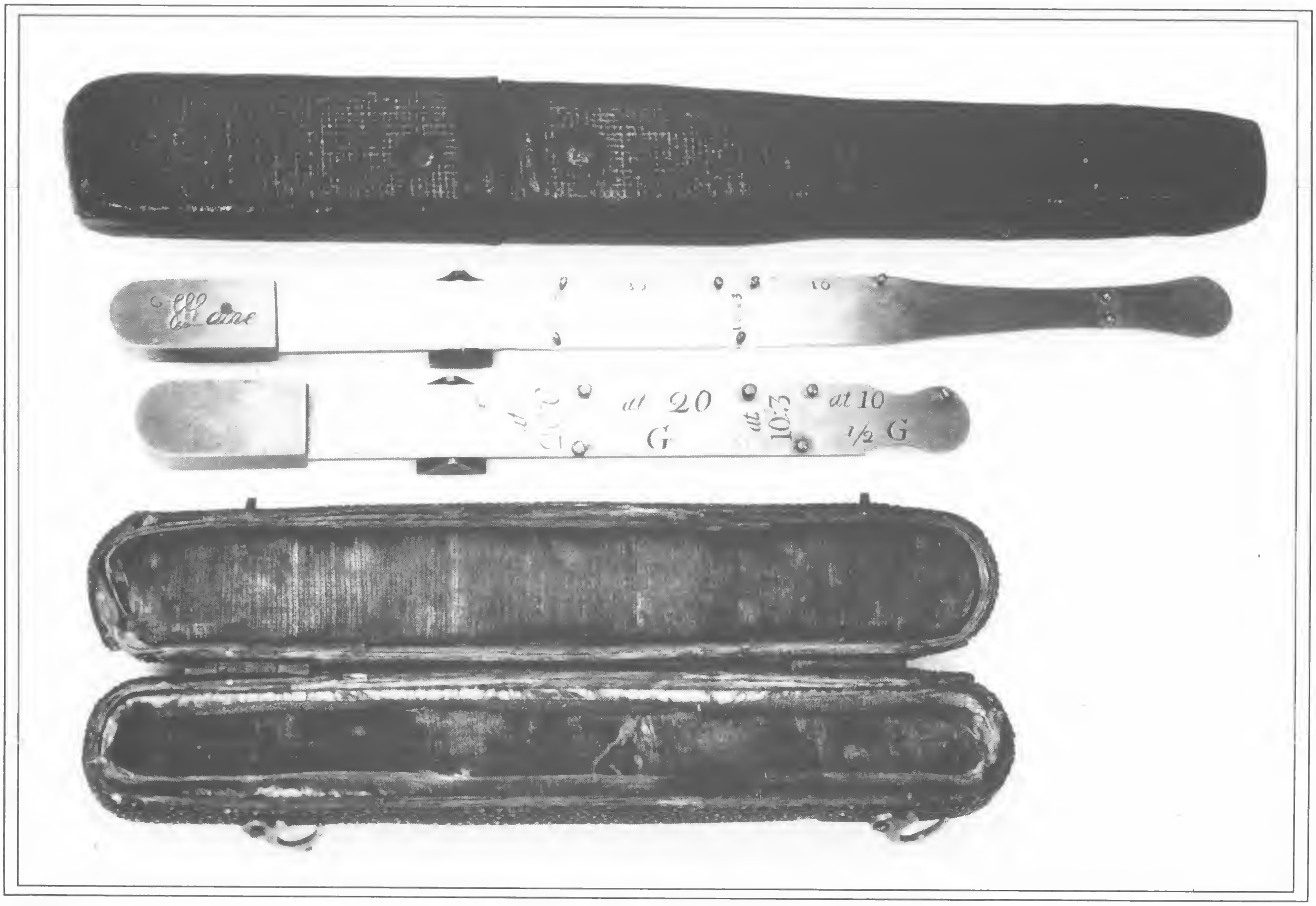

Cover Picture

These two rockers by H [?] Lane are rare. The first one that Michael Crawforth saw was in the Castle Museum, York. The signature was so lightly scratched onto the brass that it was assumed to be the name of the owner. However, when a second signed one turned up, he changed his mind and recorded H [?] Lane as a maker. It is British, and made for light guineas of the New Standard of 1774-1776.

Now three are known like the lower one in the picture. Each was made entirely of brass, with a triangular stand only ¼ inch (5mm) high and beam 4¾ ins (116mm) long. The studs gave the position in which to test the guinea. If the guinea was pushed fully towards the fulcrum, and still caused the rocker to tip, then it had lost only 6d's worth of gold, and could be passed at £1 and 6 pennies. If it had to be pushed further to the right (against the studs nearer the end of the beam) to make the beam tip, then it could only pass at £1 [that was, 20 shillings]. Similarly, the light ½ guinea could be checked, and if it tipped the beam when nearer the fulcrum, it was worth 10 shillings and 3 pennies, or if lighter, at 10 shillings. As the full-weight guinea was worth £1 1 shilling, and the ½ guinea worth 10 shillings and 6 pennies, these light coins were seriously under-weight, presumably because they had been circulating for 70 years or so, and were very worn, or because a rogue had reduced their size. These very light coins were meant to be withdrawn from circulation in 1776, but see EQM p 2082!

The long slim version at the top of the picture is the only one known of this shape and length, 6½ ins (142mm). It has a papier-mâché cap-end case. The smaller versions of Lane's rockers had either a tooled leather cap-end case or a shagreen case with proper little brass hinges and hand-cut red velvet lining.

With thanks to Fletcher Wallis for permission to show his long version.

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Associate Editor - - Ruth Hendricks Willard, P.O. Box 27565, San Francisco, CA 94127, USA.

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The Science of Weighing Yesterday

Part 1

BY W A SCHEURER

In the Beginning

When did the science of weighing begin? When did man invent the scale and a standard system of weights? There are no historical records to show when those momentous events occurred. They are lost in the mists of prehistory, along with those other fundamental devices without which there could have been no civilisation: the wheel and axle, the lever, the screw, and the inclined plane.

The oldest known scale is a tiny equal-arm balance found in a prehistoric grave in Egypt - dated at roughly 5000 BC. This first balance, in use some 7,000 years ago, and less than 3½ inches long, was carved from red limestone. See Fig. 1.

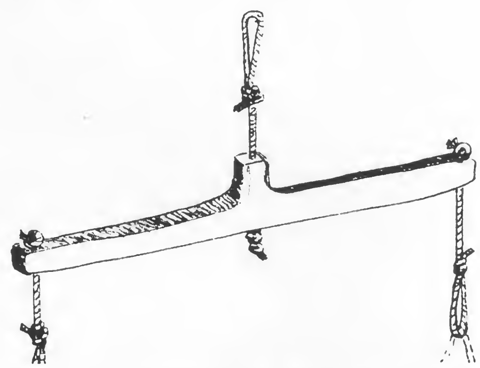


Fig. 1. Egyptian beam, 5000 BC. Pinky-red limestone.

And the oldest standard weight? According to the metrologist, Berriman, it is the Mina D. Found in the city of Lagash, in ancient Babylonia, it can be dated at about 2400 BC. (Fig. 2). This pear-shaped stone[1] is 4 inches high and weighs 1½ pounds. On the other hand, Flinders Petrie claims that some stones found in First Dynasty Egyptian graves were used as weights. If this is true, they were in use around 2900 BC.

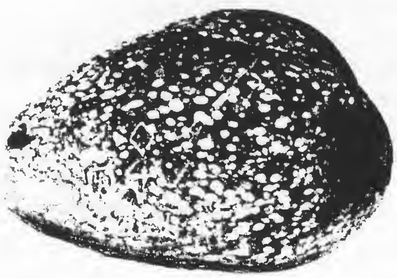


Fig. 2. Babylonian mina weight, 2400 BC, granite. Courtesy Ashmolean Museum

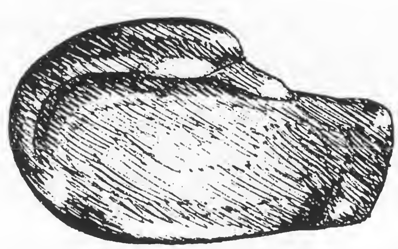


Fig. 3. Phoenician shekel weight, 1500-1100 BC, haematite. The resting duck shape was used over a vast area of the Middle East.

It is, of course, obvious that the first Egyptian balance would have been useless without weights to measure the loads and that the Babylonian Mina was used with some kind of scale, even though it is lost to us.

Two histories: Balances and Weights

These earliest historical remains show that we are confronted by two separate histories: 1) The evolution of the scale, or weighing machine; and 2) The evolution of a standard system of weights.

The history of weights is much less dramatic than that of scales since its whole concern is with the establishment of standard units of comparison. From this standard, larger and smaller units could be derived as specific fractions or multiples of the basic unit. Even the most refined modern weights are quite similar to the those ancient ones of thousands of years ago. They differ only in the high degree of accuracy with which the units can be defined and the precise ratios between them. That grandfather of all weights, the Mina, could be used today in the pan of our most sophisticated laboratory scales.

The history of the weighing machine itself, however, has been marked by dramatic changes. A modern scale system, with its banks of control panels and hundreds of electronic and mechanical components, has no resemblance to its ancient ancestor of the Nile.

Even so, it is one of the astonishing facts of history that from that first Egyptian balance down to Roman times - about 5,00 years - the equal arm balance was the only [type of] scale in existence. The Roman

steelyard, which appeared at about the time of the birth of Christ, was the first new principle in the history of the scale since the beginning of time.

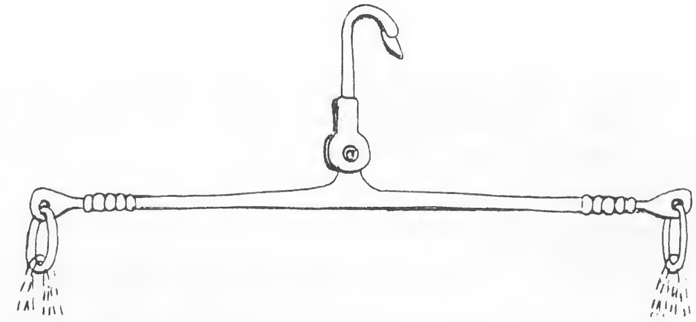


Fig. 4. Egyptian bronze beam, Upper Egypt. Note how high the fulcrum was placed. Note the ring and hole pivots. About 8 ins (220mm) long.

When we consider the phenomenal technical achievements of Egypt, Babylonia and Greece; their monumental religious architecture of pyramids, ziggurats and marble temples; their great cities with canals and plumbing; their fleets of ships and armies of soldiers; their complex and effective forms of government and legal codes; and above all their ingenious advances in mathematics and astronomy, we may wonder that they did not discover a new principle in so-important an art as weighing.

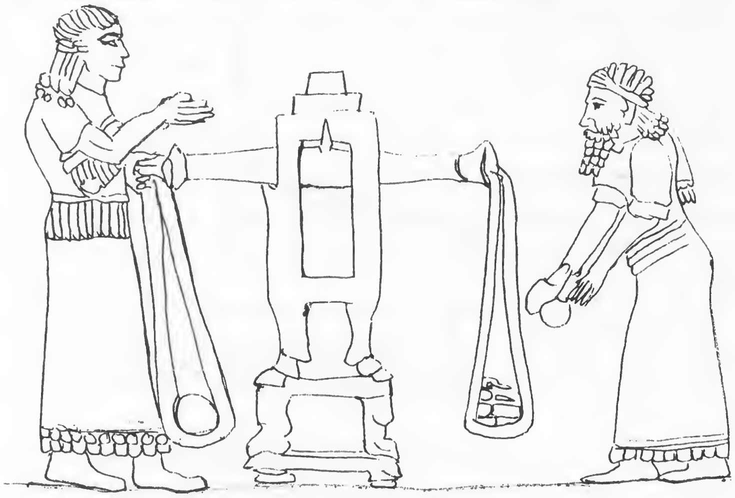


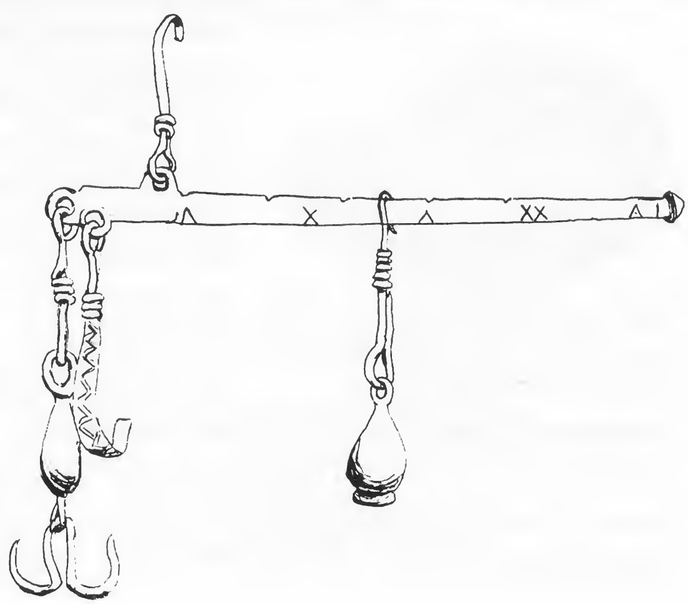
Fig. 5. Babylonian beam being used to weigh tribute offerings. Stone relief. 1500 BC. Trumpet ends were used from the Nile to the Euphrates, by the Egyptians, the Assyrians and the Minoans, from 2000 BC and yet still used on bronze beams in Europe up to the 16th century.

But the reason is clear. For the equal-arm balance is still today the most accurate means of comparing a load against a standard unit of weight as witness its extensive use in our most modern scientific laboratories.

Curiosity and Commerce: Double Root of the History of Weighing

With no historical records to the contrary, we may assume that early man first developed a means of weighing objects as a result of his own curiosity about the world around him. He must have looked at the mountain, or the bird, or the tree, and said, "How high?" At the running animal, and said "How fast?" At the lake, and said "How deep?" At the distant forest, and said "How far?" And he must have picked up many a stone, and said "How heavy?" He could find the answers only by devising standard units of weight and measure. The satisfaction of intellectual curiosity has perhaps been the chief motivation for all of our great scientific discoveries.

Fig. 6. ➢➢ Roman turn-over steelyard, bronze with lead 'link' above the load hooks to counterbalance the long blade. Showing the heavy side, 5-25. The lighter side weighed 1-8 libra [pounds]. Note that the numerals are not aligned with the notches on this one. Turn-over steelyards were used extensively by the Romans for trade weighing in Pompeii and Herculanium before they were buried in 79 AD, so it is assumed that the turn-over steelyard was developed before the time of Christ.



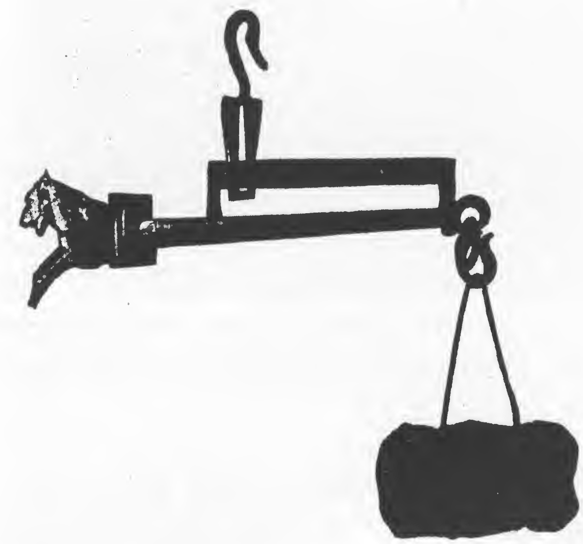


Fig. 7. ⮝⮝ Roman bismar. Bronze. Very decorative counterpoise. 100 BC. When was this idea thought of? Note that the heavier the load, the closer were the graduations, and the less accurate they were.

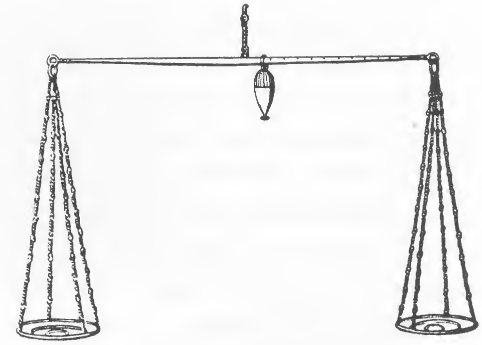


Fig. 8. ⮝⮝ Roman equal-arm beam with rider-poise. Bronze. It is not known whether this idea was developed before the idea for the turn-over steelyard.

Fig. 9. ⮞⮞ Roman steelyard poise, missing suspension loop. Bronze with gilt coronet round the helmet and gilt below the bust. 1½ ins (35mm) high. The Romans developed the poise into an art form, sometimes abstract, but the ones desired by collectors are the natural forms; portraits of men and women, gods, warriors and lions.

Courtesy Christie's South Kensington

But the development of civilised life demanded standard units of weight and measure. There can be no extensive commerce between peoples without some form of reference and comparison which will visibly demonstrate the equity of the transaction. That first Egyptian balance is testimony to the need for some more objective standard than the human senses.

Man the Measure

At the beginning of the first civilisations, man himself became the original measuring device. He found that his own limbs could provide a crude but satisfactory linear measure. From his body he developed such units of measurement as the digit, thumb, palm, hand, span, cubit, yard, fathom, foot and pace. These proved so convenient that, in spite of their obvious variability, some of them are still used today.

But it was a different matter with weights. There was nothing about the human body which offered a visible means for judging differences in weight. To compare weights, early man could rely only on his sense of "heft" - a method so arbitrary as to be almost useless in commerce or construction.

From Tote Pole to Balance

With no history to guide us, we can only assume that the first great step towards a system of weights and measures was derived from the "tote pole", or coolie yoke. Undoubtedly some primitive, but clever, fellow first learned that a heavy load could be carried more easily if it were divided, and each part hung from the ends of a pole slung across the shoulder. The more balanced the loads, the easier it was to carry them.

From the tote pole it seems to us now but a step to the equal-arm balance. By suspending the pole at its centre, the load hanging from one end could be balanced against some standard hung from the other. And with this first great step we have come to the beginning of the history of weighing.

The Three Basic Scale Components

Every weighing system, from the most primitive to the most modern, consists of three basic elements: 1) the load receiver; 2) the load sensor; and 3) the readout. Looking once again at the primitive Egyptian balance, the cord suspended from one end of the beam is the load receiver - that part of the scale which holds the load to be weighed. From the opposite end of the beam is suspended the load sensor - in this case a weight against which the load is to be compared. And in this primitive balance the only readout is the eye which must judge when the load is exactly balanced by the sensor. No matter how complex or ingenious our modern scale systems, they all incorporate these three basic elements of weighing. And the history of the science of weighing is the story of man's progressive ingenuity in discovering methods for conveniently holding all types of loads; more exact load sensing devices; and more accurate, faster systems of readout.

After 7,000 years

The science of weighing depends upon one simple function; accurate comparison with a standard unit. The increased accuracy of comparison, the increased standardisation of the units, will measure our progress. And how far have we come after 7,000 years? There are in use in the world today some 5,000 basic and derived units of weight, measure and capacity. Many backward countries still use quite primitive systems of weights, having an accuracy perhaps no greater than one part in a hundred. But the instrumentation in the more technologically advanced countries provides an accuracy of one part in many millions. The number of different units is not so important. It is accuracy of comparison which counts. When we can say that one meter equals 1·093613 yards, or that one pound equals 0.45759837 kilograms, this is science. When we can say that the U.S. bushel equals 0.9689 British bushels, and that this in turn is equivalent to 35.2381 liters, our technology has realised the goal of accuracy in scientific measurement, accuracy of comparison with standard units.

Today we measure accurately the length of a lightwave, or of a gamma ray, in terms of the Angstrom unit, one ten billionth of a meter in length. Or we can measure that much of our universe which is know to us through our radio and light telescopes, and here the standard unit is the light year, a linear unit five trillion, 878 billion miles long. We can weigh the tiniest known physical particle, the electron, and find that it is 1/910,700,000,000,000,000,000,000,000,000 of a gram (one 910,700 billion billion billionths of a gram). Or we can measure the weight of our own earth, and find that it is six billion billion grams. These illustrations show how far we have progressed since that first Egyptian balance.

The Evolution of Weights

The Westward Course of the Evolution of Weight Systems

The history of weights shows several significant trends. In the first place, while almost all primitive societies have, and have had, some system of weights, it is only that group of highly developed civilisations which can claim the development of exact standards. Each of these civilisations arose from small beginnings to astonishing heights of cultural and technical achievement, creating powerful empires and great world cities, and then declined to comparative insignificance, overcome and superseded by other rising civilisations. The earliest of these great cultural units appears to have been the Babylonian civilisation, or, more properly, the Sumerian Akkadian. This first civilisation began its organised evolution in the Tigris-Euphrates valley around 3000 BC.

Fig. 10. Babylonian shekel weights. 1500-1100 BC. Range from 45 to 2.5 g. The hardest stone used was haematite, but red limestone, diorite, granite and the metal bronze were used.

Courtesy Christie's South Kensington

Fig. 11. << Egyptian stone weights, largest 950 g (1 Sep?) down to 1.4 g ($^{1}/_{8}$ Kedet?) Granite. 1500–1100 BC.

10 Kedet=1 Deben
10 Deben=1 Sep

Courtesy Christie's South Kensington.

About a century later, the second great civilisation - the Egyptian - began its recorded evolution in the Nile valley. For more than a thousand years, as far as we know, these were the only civilisations on our planet.

About 1500 BC the Indian civilisation was shaping itself in the Indus valley, and several centuries later the great Chinese culture appeared in the East.

From that time onward the rise of new civilisations followed a generally westward course. Around 1200 BC, the Hittite-Assyrian civilisation grew to power north and west of the old Babylonian. About the same time the Hebrew civilisation spread over Palestine.

Fig. 12. ^^ Egyptian weights. Ram, 43 g, 1250 BC. Duck, 15g, 1000 BC. The Egyptians made many animal-form weights, some very rare, of mice, rabbits, tortoises, frogs, lions, fishes and bulls. Courtesy Christie's South Kensington.

Fig. 13. << Assyrian stone weight. 900–700 BC. Says '10 Shekels true.. Rare.
Courtesy Malter Auctionhouse.

In the years around 1100 BC. the Graeco-Roman, or Classical, civilisation grew up on the Greek mainland and the islands of the Ionian and Aegean Seas. This powerful civilisation, which died with the fall of the Roman empire, was succeeded by the Byzantine-Arabic civilisation. Arising much further west, around 200 BC, this culture spread westward and dominated the whole of the Near East and a considerable portion of Europe until the 15th century AD.

Still moving westward, the Western civilisation began to grow from the remains of Charlemagne's loosely constructed empire, about 900 AD.

But even before Western civilisation began, far to the west across the Atlantic Ocean, there appeared the Maya and the Inca civilisation in Peru, both around 500 AD.

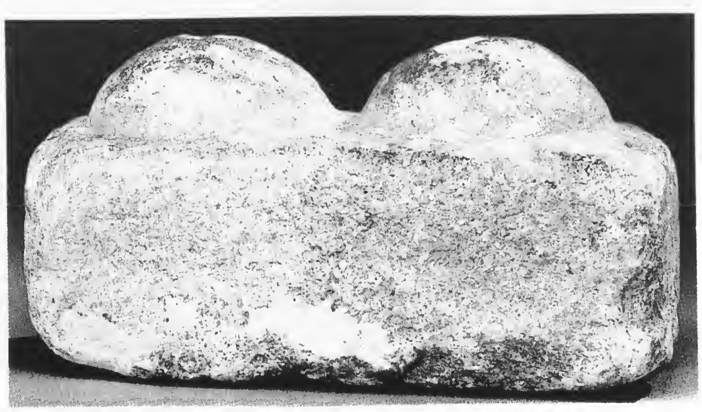
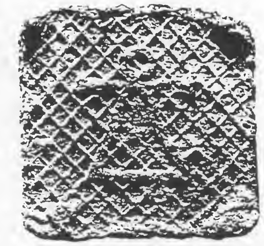


Fig. 14. >> Greek weight. Marble. About 500 BC. 2730 g. A type attributed to the Temple of Byblos. [See Malter catalogue, April, 1979.]
Courtesy Christie's South Kensington.

Fig. 15. >> Greek weight to the Phoenician standard. 1 mina, 450 g. Lead. When the Greeks used the Phoenician standard, the mina weighed 450 g. In about 100 AD they changed to a lighter standard mina weighing 517.5 g. In about 200 AD they changed to the Roman standard mina weighing 657.5 g.[2] Courtesy Münz Zentrum Auktionhouse.



At the same time that the great American civilisation was beginning on the North American continent, the ancient Oriental civilisations of India and China were being superseded by another, half-oriental, half-European: the Russian, which was beginning to take on a semblance of unity after the territorial acquisitions of Ivan the Terrible in the 15th century and Peter the Great in the late 17th.

What is significant for us is that each of these great civilisations developed its own system of weights, and each, in general, retained their own system in spite of the gradual spread of universal commerce.

The Rise of Standard Weight Systems

Throughout this long and shifting pattern of historical evolution, with its continual rise, expansion, and fall of great civilisations, there appears another central tendency: the gradual unification of hundreds of local systems of weights within a civilisation into a general system of standards established by a central government. For example, the 17 known standards of early Egypt were reduced to 8 over the course of the centuries.

While stone weights apparently were the first standard units, the cereal grain became the smallest unit of weight in many of these civilisations - a unit still used today. It was generally stipulated that the standard grain should be chosen from the centre of the ear, and dried. While grains of uniform size made a fairly reliable, and universal, unit of weight, they varied in the amount of moisture they absorbed. Today, there are 7,000 grains in the pound avoirdupois and 5,760 grains in the troy pound.

Babylonian Weights

Looking briefly at the various systems devised by the great civilisations, we find the Mina and the Shekel to be the basic units of the Babylonian system. The previously mentioned Mina D weighed 2.16 pounds. Fig. 2. Archaeologists have also found weights of five Minas, in the shape of a duck, and a 30-Mina weight in the shape of a swan.

The Shekel, familiar from the Bible as a standard Hebrew coin and weight, was one of the most ancient Babylonian weights, and was equal to 0.036 pounds, or a little more than half an ounce. In Babylonian terms, the Mina N was equal to 60 Shekels.

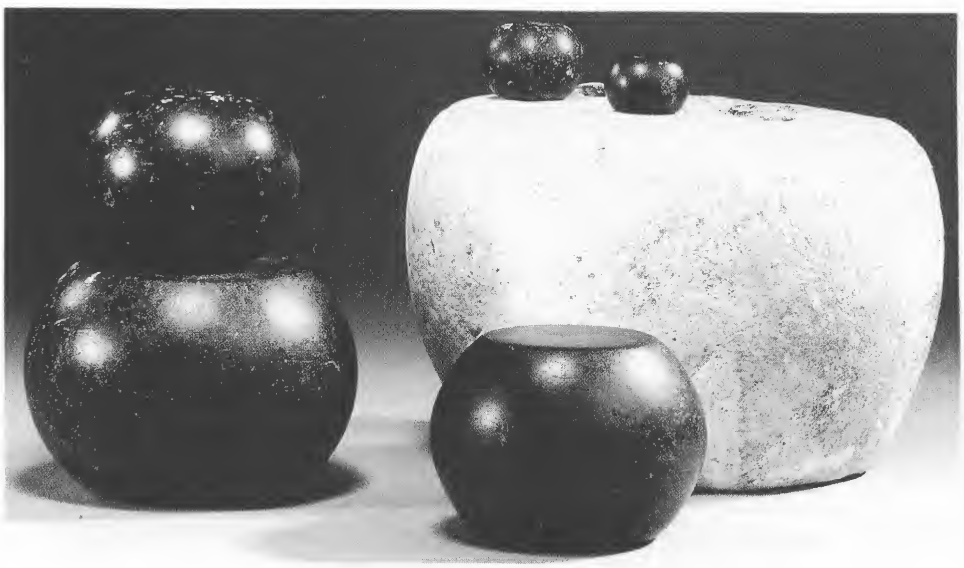
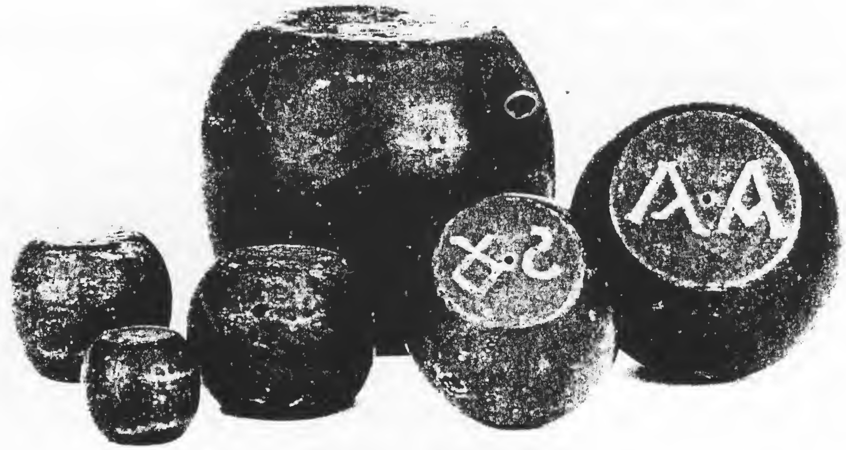


Fig. 16. Roman stone weights. About 100-200 AD. Smallest 5 shekels. The largest of these weights must have been difficult to lift and manoeuvre. See EQM p 1332-1339, for a particularly large and inconvenient weight.[3]
Courtesy Christie's South Kensington

Fig. 17. >> Eastern Mediterranean. Bronze with silver inlay. Probably made under Roman jurisdiction, 300-500 AD.
Courtesy Christie's South Kensington



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Egyptian Weights

Historical evidence of Egyptian weight systems is much more extensive than the Babylonian. The basic Egyptian system appears to have been founded on the Sep, the Deben, and the Kedet (or Kite). The basic ratio was one Sep equals 10 Debens equals 100 Kedets. However, there were many different Kedets, ranging in weight from about 70 to 292 grains. This system of standard ratios only appeared after Egyptian civilisation was well advanced. In an earlier age, the gold Deben was itself the basic unit. Much later the Kedet became the standard reference.

About 3,400 different weights have been recovered from ancient Egypt, some in simple geometric shapes, others in a wide variety of human and animal forms.

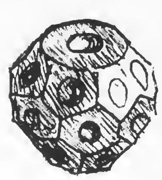


Fig 18. Eastern Mediterranean, under Roman jurisdiction. Bronze 1 uncia weight. 600-700 AD. Polyhedral weights were first used in the Eastern Mediterranean before the time of Christ, made of lead, but the crispy-formed bronze versions were used in this area right through the Byzantine period under Islamic jurisdiction, until at least 1500 AD. The number of sides and the number of concentric circles varied, but the charm of these little (under 1 inch diameter, normally) weights is noticeable. Because of the exact geometric shape, it was difficult to alter them without its being very obvious.

Indian and Chinese Weights

Very little has been discovered about any extensive Indian weight system and still less about the ancient Chinese. Some 288 specimens of stone weights have been found in the Indus valley excavations. Although they are without rating marks, they range in mass from 1.5 to 13.5 grams. Since these series of cubic stones decrease in size in an orderly pattern, it is clear that the early Indians had a standard system of weight units. Centuries later there are many references to the rati seed[4] as a fundamental unit of weight.

The early development of a coinage system by the ancient Chinese is clear indication that they also possessed standard weights. One such unit, the Kin, has persisted throughout history -gold unit equal to one cubic inch of this metal.

Fig. 19. >> Islamic. ½ dinar glass weight. 762-769 AD. This can be dated precisely because Yazïd b. Hātim was Emir of Egypt for only 7 years. An advantage of glass for weight-making was that thousands could be dropped out and stamped and only ones of exact weight kept. The faulty ones could be thrown back into the melting-pot. They were cheap to make, and impossible to alter illegally. They were widely used, usually with writing on them, giving the name of Allah or praising Allah, some with the name of the ruler, Emir or Imam. The colour of the glass varied; clear, honey-colour, green, black, brown or, rarely, blue or violet.

Hittite-Assyrian, Hebrew and Phoenician Weights

The Hittites, Assyrians, Hebrews and Phoenicians derived their weight systems generally from the old Babylonian measures, and occasionally from the Egyptian.

Hebrew standards were based on the relationship between the Mina, the Talent, and the Shekel. The Sacred Mina was equal to 60 Shekels, and the Sacred Talent to 3,000 Shekels or 50 Sacred Minas. The Talmudic Mina equalled 25 Shekels, the Talmudic Talent equalled 1500 Shekels or 60 Talmudic Minas. Since the Shekel was equivalent to one-half ounce, the Sacred Mina weighed 30 ounces, and the Sacred Talent about 94 pounds.

The historian Josephus mentions a Jewish tradition that Cain, after his wanderings, built the city of Nod and became the inventor of the system of weights and measures. There is some merit to this view in light of the fact that Cain's original difficulty came about through his inability to convince God of the equivalence in value between fruit and sheep.

The First Decimal System

During this same period, about 1000 BC, the Babylonians began to use the first decimal system of weights and measures. It had its origin in the Egyptian lineal measure, the Mahi, or length of the forearm. The Babylonians took the half-Mahi as a measure of size and weight for containers. The Half-Mahi was divided into ten parts, each equal to one Thumbreadth. One cubic Half-Mahi thus contained 1,000 cubic Thumbreadths, and the weight of water filling a container of this size was reckoned at 1,000 Bekas. Two smaller units were then derived from this basic unit; the Scruple, equal to one-tenth Beka, and the Grain, equal to 1/200th Beka. Referring to a previous system, 100 Shekels equal 64 Bekas.

The Greek Weight System

By this time in the evolution of civilisations, there was extensive land and maritime commerce among the peoples of the Near East and southern Europe. As the Greeks began to build a civilisation on the shores of the Aegean and in Asia Minor, they adopted and modified the Babylonian decimal plan. The Greek cubic foot, or Pous, became the base of the system.

Since the Greek foot was equal to 12 Thumbreadths, the cubic Pous equalled 1,728 cubic Thumbreadths, or a similar number of Bekas. Or, since one Beka equalled 12 Scruples, one cubic Pous equalled 17,280 Scruples. The Greeks then divided this into smaller units: 17,280 Scruples equalled 60 Litra Weights; one Litra Weight equalled 12 Twelfth Weights; one Twelfth Weight equalled 8 Drams; one Dram equalled 3 Scruples; One Scruple equalled 20 Grains.

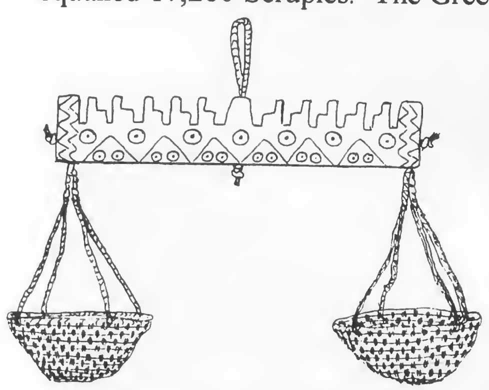


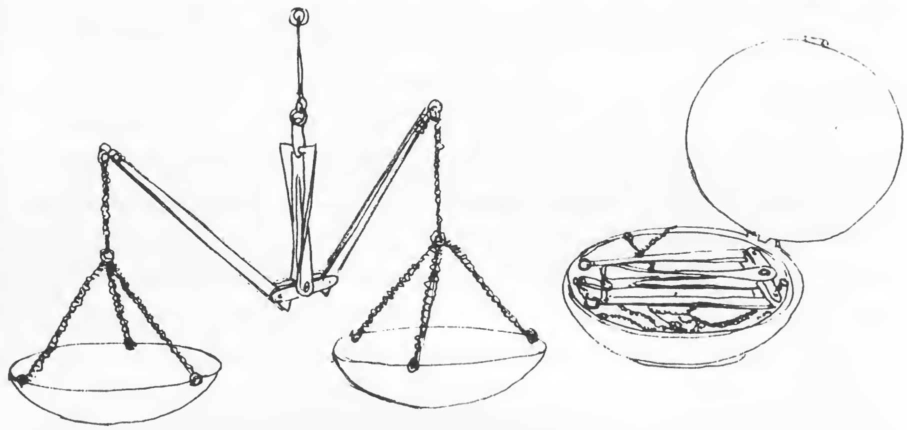
Fig. 20. Peruvian bone beam 3½ ins (87mm) long, with crocheted or netted pans. Chimu, 600-1200 AD, or Inca, 1200 to 1500 AD. The beam is carved with a row of little temples (huacas). These tiny beams were made of bone or wood, decorated with triangles, concentric circles, birds, monkeys, manta-rays, or toucans.

Roman Weights

As the Greek culture was merged with, and superseded by, the rising Roman empire, the Romans altered the Greek weight system by calling the Twelfth Weight an Uncia, from which is derived our word "ounce". Moreover, they set 16 Uncia equal to one Pondus, later to become our avoirdupois pound. Sixty Pondus weights were then reckoned to be the weight of one cubic foot of cool water.

Modifying another weight system, the Romans set 12 Uncias equal to one Libra, and 80 Libras equal to the weight of one cubic foot of cool water. This 12-ounce pound became the basis of the Troy system.

Fig. 21. Viking hinged beam, half opened. Shown also in its wooden, domed, circular box. The box was kept in a soft leather bag. Several such hinged beams have been excavated on Viking sites, with their coin weights, and often with gold coins from a huge area of Europe and the Mediterranean. Dating is difficult, ranging from about 700 to 1100 AD.



Arabic Weights

As the great Roman Empire fell into decay, first the Byzantine, then the Arabic and Turkish civilisations took its place as the leading cultures. Now still another system of weights came into use, but we know very little about the ancient Arabic standards. The barleycorn became the basic small unit of weight, and Yusdruman pound used by the Arabs was derived from the Babylonian Mina. It was adopted by Charlemagne and remained for years the standard pound of mediaeval France. The Arabic, or Mohammedan, Michtal equalled 1/72 Egypto-Roman Pound, and 100 Michtals equalled one Rotl, equivalent to 7,283 grains. This Rotl became the basis of the old Germanic weight system.

The Avery Collection in London[5] contains a set of glass coin weights with rating marks of great accuracy, indicating the high standards reached in the Arabic weight systems.

Part 2 will be in the next issue.

Notes and References

1 Although Scheurer considers this weight to be pear-shaped, it is very similar in its slightly assymetric shape to the duck-shaped weights of the Assyrians and Babylonians.

2 Shraga Qedar writes knowledgeably on ancient weight systems, and has superb illustrations in his catalogues for the Münz Zentrum Auktionhouse Köln. See catalogue XLIX, December, 1983, for a particularly helpful text.

3 Tony Morris states that he is encouraging users of 20 kilo weights to use two 10 kilo weights in preference, to reduce damage to users' backs and fingers. See p 2166.

4 Rati seed = wild liquorice seed, *(abrus precatorius*) defined by General Sir Charles Warren in *The Early Weights and Measures of Mankind*, London, 1913. He discussed the tests done on numerous samples, to ascertain the consistency of the weight of rati seeds, on p 4.

5 The Avery Historical Museum is on the outskirts of Birmingham, in Smethwick.

Author's biography

William Scheurer was the President of the Exact Weight Scale Company, Columbus, Ohio. ISASC members will recall that this company was previously the Smith Scale Co, that bought Angldile in 1925. (EQM p 2139.) Now the Exact Weight Scale Co is part of Franklin Electric Co, Levittown, PA, (the first American planned community.) They still make scales for sealers, Weights & Measures officials and industrial quality control departments.

This paper was originally presented before the 50th National Conference on Weights and Measures, Washington, DC, June 23, 1965, sponsored by the National Bureau of Standards, US Department of Commerce. It is reprinted with the kind permission of the International Society of Weighing and Measurement.

X The illustrations and the captions have been added by the editor to enable members to visualise the esoteric items that were discussed by Scheurer.

Since this wide-ranging article was written, much work has been done on the development of and influences on weight-systems. Dates before 1500 BC should be considered + or - 500 years. Some dates have been modified in the light of the new knowledge, but the general pattern that Scheurer describes is helpful.

G H Makins and the Assay Balance

Part 2

BY B J OLIVER

Although this paper is about George Hogarth Makins, the designer of one surviving assay balance prototype (held in the Science Museum), and its production model (owned by Tony Morris), both made by Ludwig Oertling, we must make an apparent digression to note what is reputedly the *first* assay balance ever made by Oertling, the Staples balance in the Royal Museum of Scotland in Edinburgh[1]. This balance is firmly dated to 1851, and is definitely a "One-off", not in accord with any standard catalogue design, but showing features of several of the standard designs as well as several unique early features.

The important point is that the Staples shows some of the features mentioned in the last paragraph of Part 1, (p 2120): twin fully-adjustable cones, and profiled centre agates. Even more interesting are the end-planes: each consists of twin agate flats with *no locating dimples*, mounted on a thin brass flat. How are these possible? With only fine point contacts and no locating dimples, why do the planes not skate on the pins? The balance is in fine working order, and vibrates beautifully with no skating. This really seems to be the bearing that Makins was groping for, but is not the one he was given. Logically this bearing comes before "dimple and groove", and the Staples is the only balance known to have it, so far. Presumably it was found wanting in some respect, perhaps it was just too difficult to set up. The idea was dropped, but the only known example works perfectly; I checked the sensitivity of the balance with no trouble at all.

So, which balance came first, the Staples or the Makins (Cover picture, page 2113)? Was Mr. Makins as innovative as he claimed to be? I feel that the two dates of 1851 and 1851/2 are too close to distinguish at this distance. I offer the hypothesis that Oertling was probably trying two simultaneous different approaches to designing the ultimate assay balance. Other features of the Staples will be noted later; back now to Mr. Makins.

His next two changes are not truly inventions of his own, but he greatly developed ideas present in the Field balances at the Mint: a really smooth release/arrest mechanism, and a more accurate placement of the centre knife on the plane, at *exactly* the same place every time; these in order to achieve greater reproducibility. The centuries-old string and pulley mechanism had long been superseded by the release lever in the base of the pillar, but with its short travel it could still produce a jarring effect as contact was made.

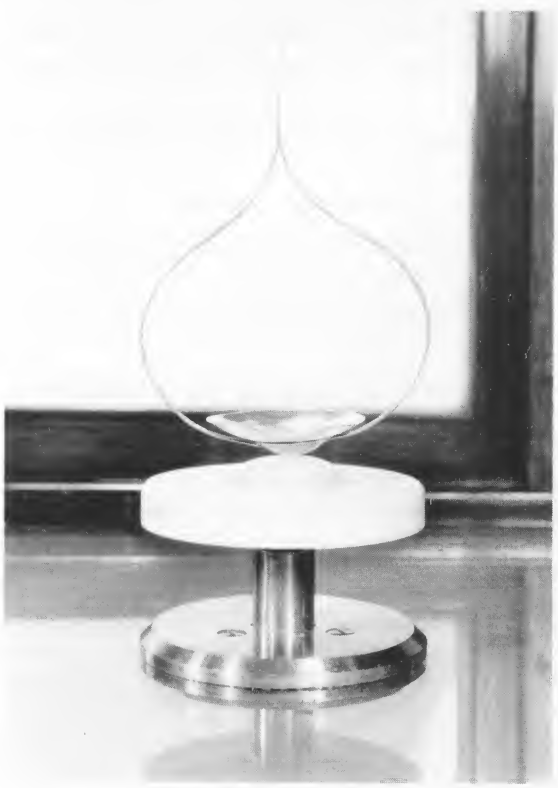


Fig. 6. The pan-hanger on the production model, showing the classic Oertling assay pan-hanger with the loose silver pan in position. The agate and ivory arrestor below, just kissing the pan holder.

The glass insert which covers the whole base of the case, had to have holes drilled through the glass to permit the rods of the arrestment mechanism to come from below the case.

Field had produced at least one balance with a greatly extended lever below the balance base board (thereby displacing the traditional drawer), and giving a more finely-controlled release. But this idea was now to be taken further. For some time, it had been the practice to have the pans resting on little tables, both as a partial relief of end bearings, and as a means of stabilising the pans when loading up. Upon release, the centre plane had then risen to meet the centre knife and lift it, beam and all, into suspension. Here, for the first time, we find that on release, the tables supporting the pans drop away and then, carefully timed, the beam is slowly *lowered* until the centre knife contacts the plane. (We now call these little tables "pan arrestors" or "pan stops".)

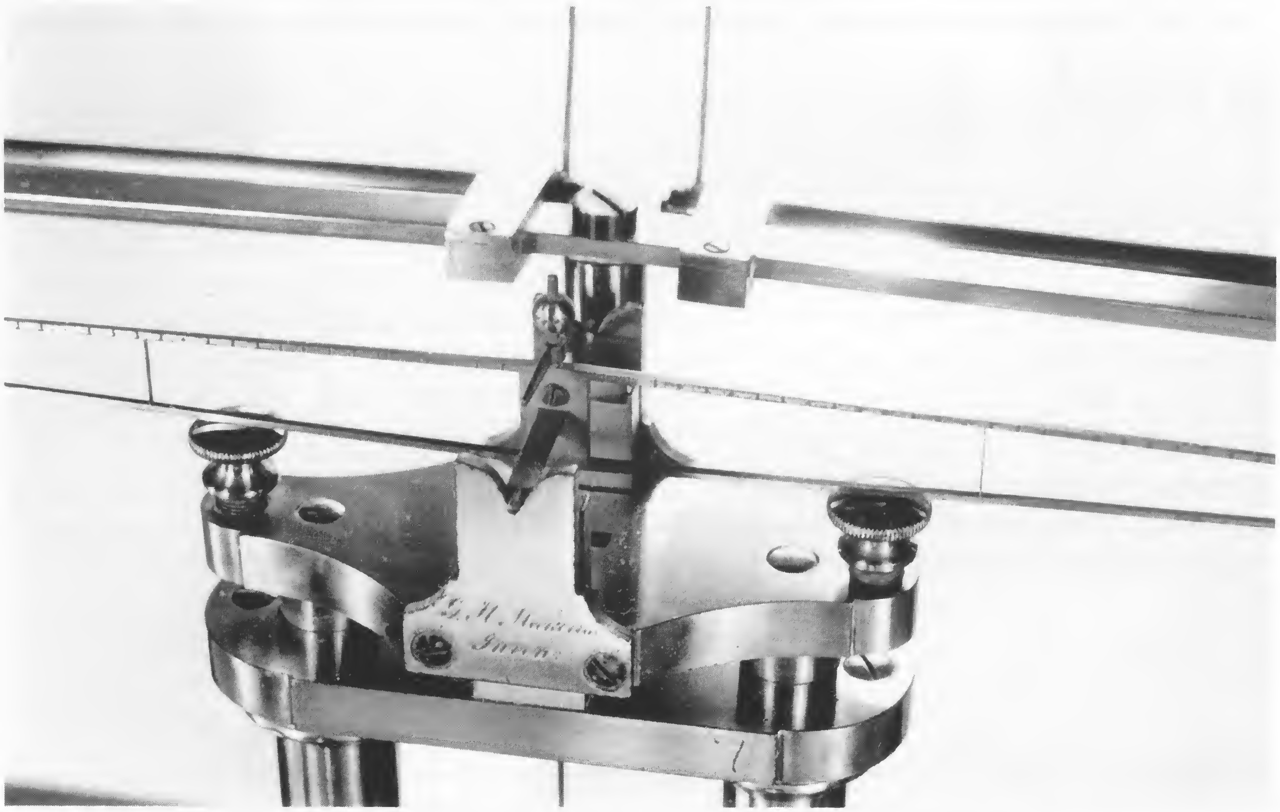


Fig. 7. The production Makins. Close-up of the front arrestment plate, engraved '*G. H. Makins Inven.*' Milled edge capstans support and locate the beam, well to the left and right of centre.

I should mention that the Staples balance has the *fully-developed* Oertling arrestment system which, at first glance, appears to invalidate Makins' priority in this area. Extended detailed examination suggests that much of the Staples arrestment is a later addition, probably much later. The only way to prove this is by completely dismantling the balance. This has yet to be done and, for the moment, I am confidently assuming that the Staples has no relevance to the development of arrestments.

As for accurate placement of the beam, here Makins improved the twin pillar idea of Field, developing it to its logical conclusion. By holding the beam fore and aft of the centre knife, there had always been the possibility of the beam twisting slightly and resting on a different piece of the centre plane each time, especially if the release mechanism was rough. By holding the beam at two points well to left and right of centre (Fig. 1, page 2116 & Fig. 7), it could now be placed in exactly the same spot each time, especially with the smoother release. By making the twin pillars truly massive (therefore totally rigid), and with the internal push rods finely ground and polished to a perfect smooth fit, Makins ensured the smooth release and placement essential for reproducible

results at this very fine level of weighing. Further, by having the widely spaced pillars, there was room to fit between them a good large divided scale for the pointer, at the same height as the pans, ensuring easier and more accurate observation (Figs. 2 & 4, pages 2116 and 2118, respectively).

Thus we have the happy union of several truly important features in balance development, that carried on down the years right to the demise of the two-pan balance: the rigid lattice beam, descending pan arrestors and a descending beam carefully timed in relation to each other, and bearings screw-adjustable both vertically and horizontally, smooth release and arrest, and a pointer scale in the same visual field as the pans. However, the story is not yet complete; two more important developments had to occur before the Makins could become a successful routine laboratory instrument.

The pans of the Makins prototype were brass disks $1^3/_8$ inches diameter hung on Platinum chains (Fig. 2). This was not a very practical arrangement for such light pans and loads, and seems to be the only part of the design that escaped Makins' rigorous logic. The prototype dates from 1851/2, and my best guess for the production one is 1856-1860. Note that the shaped stiff wire assay pan hanger has now replaced the chain version (Figs. 4 and 6, pages 2118 and 2152 respectively).

Recent investigation has shown that this new design was not entirely Oertling's original idea as we had believed. He has clearly developed the wire form from a similar one in 2 mm metal strap that he fitted to the Staples balance, and which is clearly related to a coarser strapwork hanger on a DeGrave Short & Fanner balance[2] and this, in turn, seems to have been suggested by a design of Magellan in 1781[3].

Whatever its true origin, Oertling's final design in wire was a brilliant notion, elegant, rigid, stable and practical, and it never needed even the slightest change. This distinctively shaped pan hanger is a true design classic that persisted throughout the extended duration of the Oertling No. 12

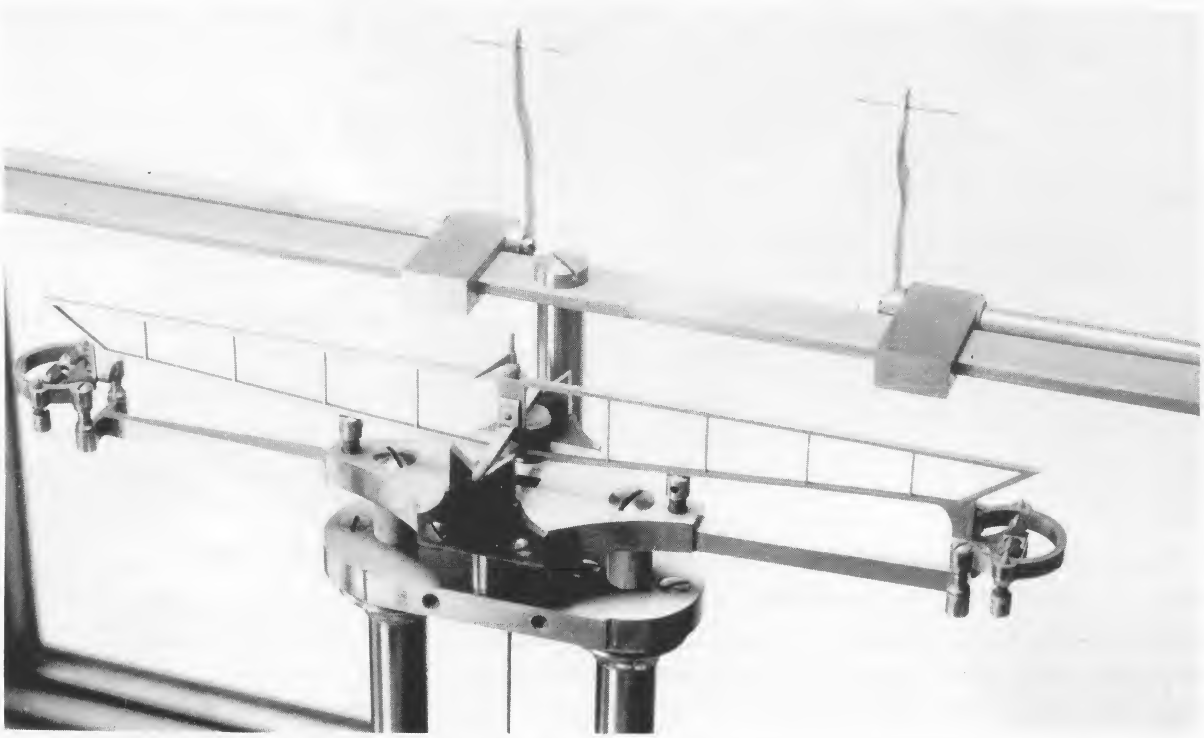


Fig. 8. The 12SBA, the final form. The beam now has four divisions each side, twin agate knives at each end, constant thickness, and a horizontal top for the rider. A full-width arrestment frame relieves the end bearings. The end planes and hangers have been removed for clarity.

series of assay balances, and it was widely copied. The elegant bow is of nickel wire, and the tiny "pan" at the bottom is actually the pan holder, 10 mm diameter. The true pans are polished silver dishes 27 mm diameter, quickly and easily removed. A less obvious change in the production version was the replacement of the steel end planes with ones of agate (Fig. 5, page 2119). The centre knife was no longer steel, but a tiny sliver of agate, ground to a knife edge and set in a brass holder. In subsequent versions the steel pins were replaced with twin tiny agate knives, giving the all-agate bearings. The reason for this is interesting.

Assay balances were subjected to acidic laboratory atmospheres, which corroded the steel knives and planes. Therefore glass cases were utilised to protect the bearings. This had the happy side-effect of preventing draughts on the balance, so the cases served two purposes. Of course, some corrosion still occurred, and agate planes were originally introduced because they would not corrode. Agate was hard to work, therefore expensive, but it soon became clear that the agate bearings not only gave better performance (higher precision), but maintained that performance for longer. This high performance could, of course, only be realised within the sheltered environment of the case. Eventually, as the technology of agate cutting and polishing improved, and the benefits were seen, assay balances became all-agate. Later, all high quality balances became all-agate too.

Now with its special pan hanger and all-agate bearings, the Makins as the Oertling No. 12 had become a fine yet practical laboratory instrument, and a commercial success too. Naturally, the No. 12 did evolve somewhat over the years. The biggest changes were the introduction of full relief of the end planes in the 12A, and the introduction of the short beam (from 10" down to 6") in the 12SB. Marrying the two changes produced the 12SBA, which was introduced in or just before 1899 (Fig. 8). This then superseded the other versions, and the 12SBA was the dominant assay balance for many decades. This model became a design classic, and as such the term "12SBA" became synonymous with "assay balance", which has been the source of much confusion for researchers such as me! The 12SBA was finally withdrawn in 1953, at least 101 years after Makins' original concept.

One of the original prototype batch was given to the Science Museum by Makins' executors in 1898, and bears a plaque to that effect, plus another plaque (Fig. 2) giving the name of the designer and the journal reference that my friend followed up. An early production version eventually found its way into "The Graveyard" of old and discarded balances at European Instruments in Oxford. It lay there for years pretending to be a No. 12, until I happened along and had the joy of discovering it, spotting that it bore a plate engraved with Makins' name. Fig. 7. I put two and two together and the rest, as they say, is history, set down here for you all to read.

Notes and References

1 Staples balance, Accession no. NMS T.1973.154.

2 DeGrave Short & Fanner, Science Museum acc. no. 1925/41. Date 1845-1871?

3 Magellan, J H, *Observations Sur La Physique*, **17**, 1781, p 43-49. It is interesting to note that he also discusses screw-threaded individually adjustable cone bearings at the beam ends, lattice beams and steel pins bearing on agate flats as the centre bearing! Subsequent text suggests that the balance was never built, and was simply an intellectual exercise in balance design. One wonders if Makins, Oertling and the DeGrave designers were aware of this reference.

Book Reviews

The following booklets are from a private collection and it is not possible to state whether they are still available from the addresses quoted within each review. Nevertheless, as standard reference material they are extremely informative and useful to the collector of antique scales. Searching for them at the given addresses or enquiring through ISASC newsletters might prove fruitful.

1 **Dictionary of Weighing Terms**, by Dr L Biétry, Mettler Instruments A G, CH-8606 Greifensee, Switzerland. 6 x 7 ins (150 x 210mm) Paperback, 130 pp, 1983.

A concise reference work containing about 700 brief descriptions that cover terms ranging from 'Absolute Weighing' to 'Zero Resetting Device'.

Each entry gives a useful short account of the term and, where appropriate a clear simple diagram or a photograph showing, of course, a Mettler balance.

2 **Terms and Definitions (for the Weighing Industry),** Scale Manufacturers' Association Inc, One Thomas Circle Northwest, Washington, DC 20005, USA. 6 x 8¾ ins (150 x 220mm) Paperback, 92 pp, 1st edition 1958; 2nd edition 1964.

Some 900 terms peculiar to the scale industry are briefly described. Some quite obscure manufacturing terms are included that will interest those involved in the detailed engineering of scales. However, there are no diagrams to help the descriptive process. The booklet contains a set of tables giving the conversion factors between many types of weights, 'Avoirdupois ounces' to 'Grains' for example.

A revised third paperback edition in 1975 (published from 100, Vermont Avenue Northwest, Washington, DC 20005), by a completely new terminology committee adds further terms and gives some additional information, but is otherwise unchanged.

3 **Glossary of Terms used in the Scale Trade**, W & T Avery, Soho Foundry, Smethwick, Warley, West Midlands, B66 2LP, UK. 5½ x 8¼ ins (140 x 210mm) Paperback, 55 pp, 1st edition, 1950; 2nd edition, 1964.

This booklet was intended to act as a guide towards uniformity and standardisation. It aimed at being a complete record of the special language of the scale industry. The 600 or so entries include many obsolete and very specialised local (Birmingham) terms i.e., 'Truan: old term for a suspended steelyard'. These obsolete terms are identified by being printed in lower case letters only. The rest, in upper case, give many extra terms to supplement those in 1 and 2 above.

4 **Rules and Regulations relating to Weights and Measures**, Department of Agriculture, Bureau of Weights and Measures, 11th and 0 Streets, Sacramento 14, California, USA. 6 x 9 ins (150 x 230mm) Paperback, 360 pp, 1951.

I found some difficulty in locating specific items in this booklet even though there is an index. Nevertheless, it does contain much that is of interest to the collector of antique scales, and dipping into it reveals some fascinating facts on such matters as 'Standards of Weights & Measures, Tolerances, and Specifications for Commercial Weighing and Measuring Devices', i.e., 'Lug dimension: Potatoes sold in Lugs shall be sold only in the Californian Standard No. 27, having dimensions.....'

P HOLROYD

ASCO

By E COHN and A RANGELEY

From Emil Cohn:

I have an equal-arm balance made by ASCO[1], with an eccentric cover 21ins (525mm) high covering the pillar and the oil-filled dash-pot. The fan-chart is mounted above the beam, working at right-angles to the plane of movement. The chart is graduated to one dram on the light side of zero, and one dram on the heavy side of zero. The hanger supports a detachable circular scoop, and there is a balance-ball between the chains on the weight-pan, [to permit adjustment in the case of the scoop being replaced]. The whole scale is mounted on a solid chunk of mahogany 19¾ins x 10ins (470 x 250mm) with adjustable-feet, and it has two spirit-levels to ascertain its horizontality.

What was my scale used for?

Figure 1. Automatic Scale Co Ltd tobacco scale, made for use behind the scenes. E Cohn Collection

From Albert Rangeley:

You have a machine made during the 1930s,[2] primarily designed for the weighing of tea, coffee and tobacco. In Britain, the Weights and Measures regulations specified that only this type of semi-self indicating scale[3] could be used for these products.

If this machine had been graduated 'Heavy' only, instead of both sides of a central zero, then it would have been used on a shop counter *in front of the customer*.[4] As it was, your machine would have been used for the same purpose, but in the rear storeroom and *not* in front of the customer.[5] Tea, in those days, was supplied in bulk to the larger grocery stores in plywood chests which were approximately 2 feet square, [and lined with tin-foil to exclude moisture]. An assistant would weigh out 4 and 8oz packets in the rear of the shop and the resultant packets then put on the shelves in the front of the shop.

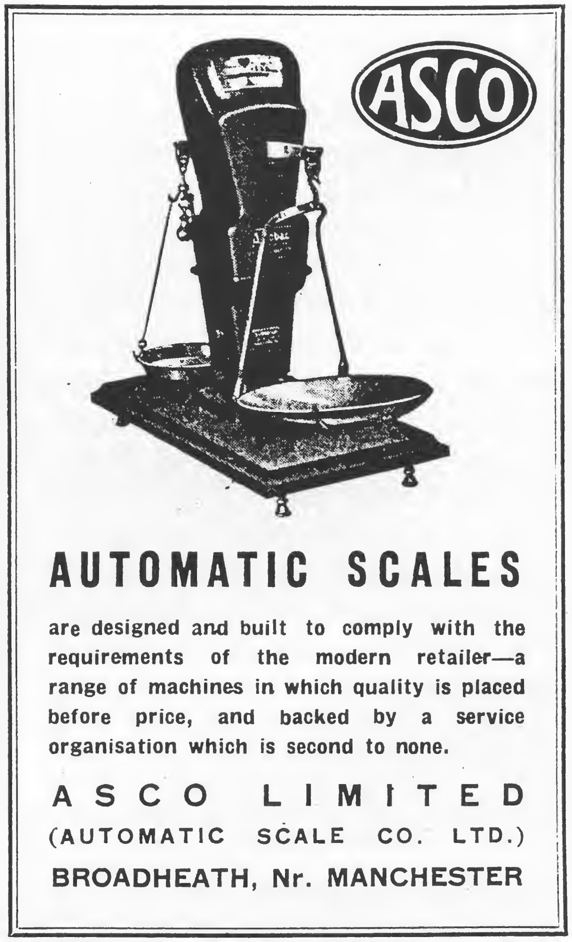
Similarly, in the specialist pipe-tobacco shops which offered lots of varieties, the ½, 1 or 2oz packs would be weighed in the rear of the shop before being put into display counters in the shop.

The scale had other uses, such as check-weighing packs which had come from a production line of automatic weighing- and packing-machines. A random check of these products would be taken intermittently in the factory to make sure that the machine was operating correctly.

Your machine would be comparatively rare because W & T Avery Ltd had the greatest proportion of the market in this type of machine and production by ASCO would be fairly limited.[6]

The ASCO company was taken over by the German firm of Bizerba about 35 years ago[7] and the Manchester factory ceased production before 1965, when Asco-Bizerba submitted to the Board of Trade a self-indicating, price-computing counter machine from York House, Empire Way, Wembley [on the outskirts of London]. They submitted yet another semi-self-indicating counter

Fig. 2. ➢➢ ASCO advertised in the Inspectors' Handbook of 1939, using an illustration of exactly the scale that Emil Cohn owns.
Courtesy R Myers & E Cohn



scale in 1968, this one pre-loaded to 1 lb, with a Beranger linkage. It was labelled *To weigh pre-determined loads of 1 lbs only*, and *Not to be used for weighing in the presence of the purchaser*. The new company made lots of types of food-preparing machinery and the sale of scales diminished. However, the advent of electronic scales increased its fortunes, but not for long.

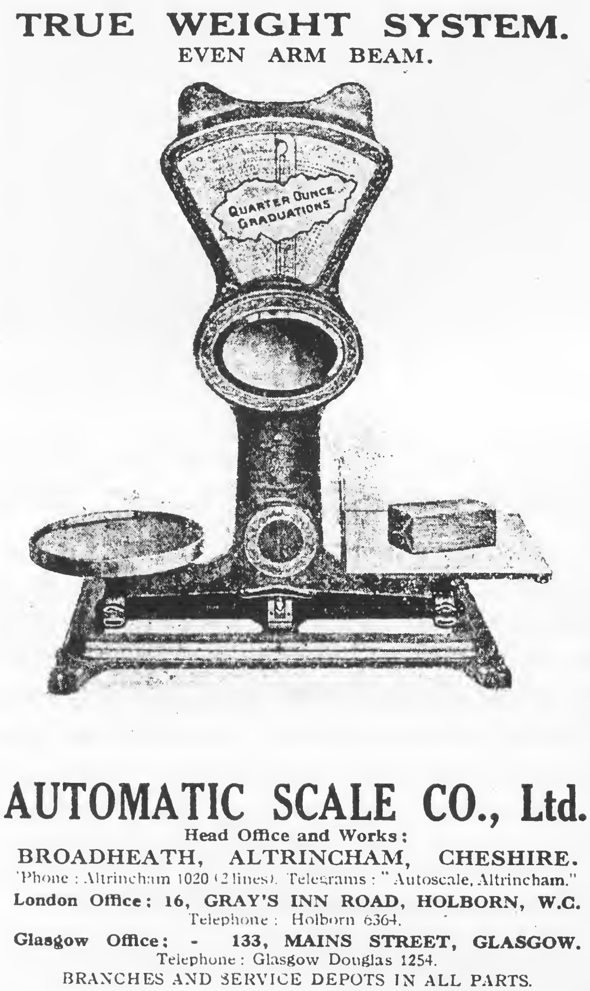


Fig. 3. ⮝⮝ Automatic Scale Co Ltd, advertisement in the Inspectors' Handbook for 1922. Note that they had branches and Service Depots in all parts.

Fig. 4. ➢➢ ASCO Ltd, advertisement in the Inspectors' Handbook for 1950. Note the similarities between the 1922 and the 1950 machines.
Courtesy H Chandler

The oil bath in the lower part of the column is known as a 'Paddle Dashpot'[8] to differentiate it from the more normal device, which has a cylinder with a plunger. It was used only on very fine shop scales.

I disposed of such a machine about two months ago, and this was the only one I had seen in over twenty years. The machine is now used as an 'antique' display item in a shop in the south of England.[9]

Notes and References

1 The Automatic Scale Co. Ltd was already a flourishing company by 1922, when they inserted an advertisement in the Inspector's Handbook. They took the trade-mark ASCO in 1932, when they were at the Timperley Works, Manchester Road, Broadheath, Altrincham, Cheshire.

2 The Automatic Scale Co Ltd took out several patents, including no. 202481; 6922[?]4; 216609; and 224476 [1925], consistently for shop counter scales and their parts. They featured frequently in Board of Trade Weights and Measures Act Notices through to the 1960s, again, always for shop counter scales.

3 'Semi-self indicating' meant that the main mass was determined by using weights in the normal way, on one pan, while the load was on the other pan. The last little amount (in this case 1 dram) could be determined by reading the fan-chart. This gave very good accuracy very rapidly, without the need for minute weights for parts of a dram.

4 Such a scale, to be used before the customer, and patented in 1925, was illustrated in EQM, page 715. The roberval linkage kept the pans horizontal, and a pendulum turned the pointer on the fan-chart, indicating 0 to 1 lb, and giving the price for 27 increments.

5 The Automatic Scale Co Ltd sent a semi-self indicating scale to the Board of Trade in 1929, with indications only on the Heavy side of zero. This *looked* like a roberval scale with a cover over it, and a fan above the beam. The diagram showed that it had spring resistants operating the pointer, as a substitute for the earlier 1924 version, which had a pendulum resistant, a fact mentioned in the comments by the Board of Trade inspector. Then, six months later, the Automatic Scale Co Ltd put in another semi-self indicating scale, and the cover was over an inverted roberval mechanism! This meant that the company had four constructions, at least; equal-arm, inverted roberval, spring and pendulum, all in shop counter scales.

6 ASCO was only one of several companies trying to compete with Avery's. Other companies that submitted semi-self indicating scales for the approval of the Board of Trade between 1929 and 1960 included

Berkel Auto Scale Co	Chas. W Brecknell Ltd	British Scale Co Ltd
Day & Millward Ltd	Elliott Bros (London) Ltd	A S Farrell & Co
Gardner & Sons	Herbert& Sons Ltd	Hobart Manufacturing Co Ltd
Leicester Scale Co Ltd.	Mattocks Automatic Scales Ltd	Recsi, of Liege, Belgium
P Rogers & Loach Ltd	J & J Siddons Ltd	Vandome Titford & Co Ltd
W A Webb Ltd		

All these companies were actively producing these scales, yet the editor has rarely seen a semi-self indicating scale by any of these lesser companies.

All these semi-self indicating machines were in competition with the self-indicating machines, the price-indicating machines and the roberval, inverted-roberval and pillar scales. This plethora of machines was needed to satisfy the large number of scales used in the front of so many shops, and the separate needs in the rear of the shops.

7 ASCO-Bizerba Ltd were still at the Timperley Works in 1966, and still making shop counter-scales in 1971.

8 A paddle dashpot had a pot of oil with a paddle sweeping through the oil horizontally, the paddle being attached rigidly at its top end to the beam. When the beam moved, the paddle moved but slowly, resisting the momentum and damping the movement. The accuracy of the beam was not greatly affected; merely the speed of swing and the length of swing were. Vandome Titford & Co Ltd made a similar semi-self-indicating scale with a paddle-dashpot, submitted to the Board of Trade in April 1929.

Americans were quite familiar with oil-dashpots from about 1900, in their computing scales. W & L E Gurley published a book in 1910, *Handbook for Sealers of Weights and Measures*, in which they state *The [computing] scale should not move too freely or stop too quickly. This is adjusted in the platform type by means of a plunger and dashpot filled with oil or glycerine. Regulate by the set screw or the lever at the top of the dashpot.*

9 This points up the need to collect such rarities now. Emil Cohn is to be congratulated on his perspicacity in buying this unusual item. In parenthesis, Jan and Bill Berning have a top-pan household scale *not for trade use* by ASCO. What other types of scales were made by ASCO?

Shaw's Scales and Weights

BY L S WEISS

Note by M A Crawforth: George Bernard Shaw was born in 1856 in Dublin, but like so many other talented Irishmen of his day, it was while living in England that his talents shone out. He wrote witty and stimulating plays which opened up people's attitudes to social problems without upsetting their susceptibilities too greatly. In his clever and humorous way he made people think about illegitimacy, capitalism, snobbery, pacifism, religion, divorce, prostitution, the arms trade, poverty and many other contentious moral issues. He got the Nobel Prize for Literature in 1926 and lived to enjoy the money, not dying until 1950.

Gadgets were what he loved, and the house is crammed with them: thermometers, barometers, cameras, fluorescent lights [and] ball-point pens.[1] *The study was Shaw's workroom, where at the large encumbered desk before the window he sat down to attend to his correspondence. His desk remains exactly as he left it with his pen and gear, and the pocket dictionaries - French, German and Italian - and the tiny biographical and historical dictionary, which he used for immediate reference ... The smaller desk on the left of his own was reserved for his secretary.*[2] To the rear and above her desk stood the postal scales. See Fig. 1.

Fig. 1. G B Shaw's study at Shaw's Corner, Ayot St. Lawrence, near Welyn, with the two desks, and the postal scales to the left of them, on a protruding shelf. The anglepoise lamp was a very expensive and much-admired gadget in its day.

Fig. 2. ≺≺ Left to right. Salter No. 11. Box of gram weights, 100g down. Salter Parcel balance. Samuel Turner Senior roberval letter scale, retailed by Houghton & Gunn.

Shaw, and his secretary, Blanche Patch, handled volumes of letters and parcels, both in and out. His biographers reckon that he wrote on the average, 10 letters a day for 75 years of his life. And there were manuscripts to almost every country with a printing press.[3]

If the estimate of correspondence is multiplied out, the total exceeds 170,000 letters. The book review of the New York Times of June 30, 1985, reviewed Shaw's collected letters of 1911-1925. This volume is the third of collected letters and consists of 989 pages! These books do not include letters written by Shaw in the last 25 years of his life. According to the editor of the most recent volumes of Shaw's letters, he believes that Shaw wrote at least a quarter of a million letters and postcards.[4] It is little wonder that he needed to have scales and weights in his study.

Salter Letter Scale

Shaw had a Salter Letter Scale no. 11. Fig. 2. The overall height is 7 ins (175mm), and the enamelled white dial is 3 ins (73mm) across. The circular brass plate for letters is 3¼ ins (80mm) in diameter. The main body is cast brass, coated in a dark green wrinkled stove enamelling, and the inscription in the centre of the dial is shown in the figure on the left ≺≺. On the right side of the casing, about 4 o'clock, there is an adjusting knob. The outer scale is from 0 to 24 ounces and the postage rate goes from 1½d to 7d for 24 ounces.[5] The postal rates were in use from May 14, 1923 until May 1, 1940.[6] Since this is the plain version of the Salter Scale No. 11, it must have been made after 1929.[7] Hence it must have been purchased by Shaw in the 1930s when he resided in Ayot St. Lawrence.

SALTER
LETTER BALANCE
No. 11
24 oz by ½ oz
MADE IN ENGLAND

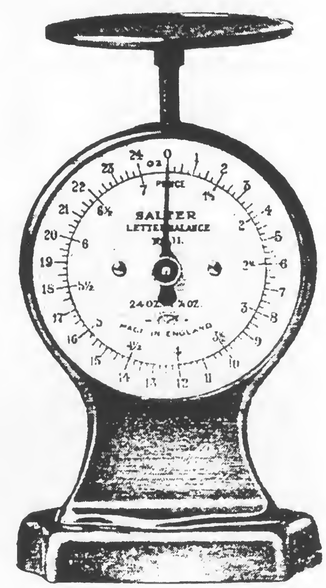


Fig. 3. Geo. Salter & Co Ltd, 1939 catalogue. Plain version of the no. 11. For a clear photograph see EQM p 524.

Roberval Postal Scale

Shaw also had a roberval postal scale in his collection. The base of maple, with button feet of wood, was 9½ x 5½ ins (240 x 133mm) with a brass beam of 5 ins (154mm). On the left the circular weight-pan is 2½ ins (60mm) in diameter, and the letter plate is 3½ ins (87mm) across and the leg beneath it is 4¼ ins (105mm) long, [with a semi-circular diversion round the cross link.[8]] Stamped on the latter are the postage rates. See Fig. 4.

Fig. 4. ➢➢ Postage rates on the letter plate of the Houghton & Gunn roberval scale.

POSTAL RATES FOR LETTERS			
Not exceeding		4 oz	1d
"	"	6 oz	1½d
"	"	8 oz	2d
"	"	10 oz	2½d
"	"	12 oz	3d
"	"	14 oz	3½d
"	"	16 oz	4d

The postage rates indicate that the scale was manufactured during the period from June 22, 1897 until November 15, 1915.[6] Stamped on the right side of the beam is *Warranted Accurate* and on the left side of the beam is *Houghton & Gunn, 162 Bond Street*. Houghton & Gunn were retailers [of stationary supplies]. The A frame which supports the beam was characteristic of Samuel Turner Senior's construction, and is similar to the S Mordan style of construction.[9]

The central weights in a pile on the base are for ½, 1, 2 and 4 oz, and the two large weights either side are 8 oz brass weights. They have no other markings on them.[10]

Salter Parcel Post Balance

For parcel post packages, most likely manuscripts, Shaw had an old Salter Parcel Post Balance, no. 35, which is depicted in the 1893 catalogue, page 61. On the dial is ➢➢

POSTAL PARCEL BALANCE
SALTER
No. 35
BRITISH MADE
11LB BY 1OZ

The cast-iron body has a white enamelled dial 6¼ ins (155mm) in diameter, the brass plate is 9 x 7 ins (225 x 175mm) and the height overall is 11ins(278mm). There is no adjusting screw.[11]

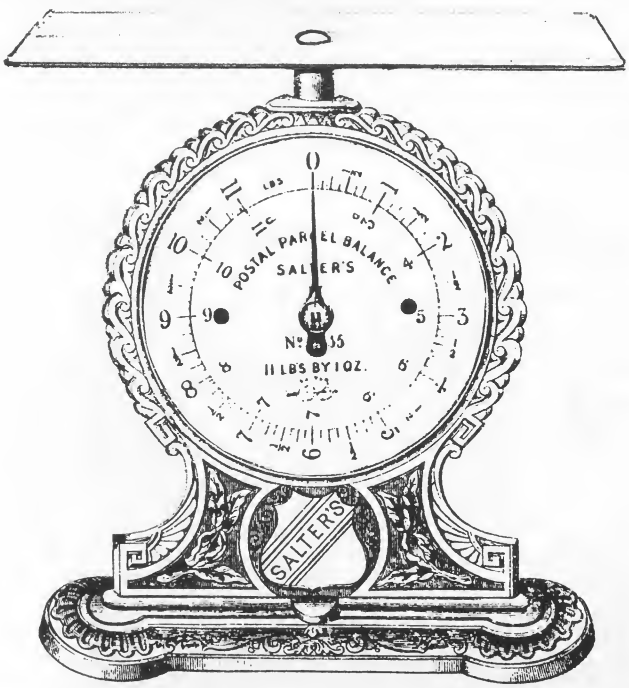


Fig. 5. Geo. Salter Postal Parcel Scale, no. 35. The version made after 1897 (for parcels up to 11 lbs). The curly-edge on this top-pan balance is unusual, as Salter normally had smooth-edged cases.

The postage rate is 1 lb for 3d, and each additional pound [up to 7 lbs] is 1½d more.[5] This rate for parcels was in use from May 1, 1886 until May 31, 1897.[6] It is likely that Shaw bought this scale while living in London with his mother and sister, Lucy, prior to his marriage to Charlotte Payne-Townsend in 1898.[12]

Pocket Spring Balance

Evidently not left in the open was a spring balance found in a drawer in Shaw's desk. It had a total length of 7¼ ins (180mm), and an iron rear casing with a brass face 3½ ins (85mm) long. There are graduations from 0 to 15, not so designated, but in pounds. At the top of the brass face is stamped *Pocket Balance*, and at the bottom *Registered*, but with no indication as to maker or year of manufacture.[5]

Box of Weights

George Bernard Shaw was also the owner of a set of boxed weights contained in a wooden box with tweezers. The brass were cylindrical with knobs, and graduated in size; 2, 2, 5, 10, 20, 50 and 100 grams, and with the smallest ones missing. Unfortunately there is no indication of the maker's name or of the year of origin.

With this basic collection, George Bernard Shaw would make an excellent honorary member of the International Society of Antique Scale Collectors.

Acknowledgements
With particular thanks to G Fraser Gallie, and Michael Robinson, founder member of ISASC.

Notes and References

1 Lambert, E, Historic Houses, George Bernard Shaw, *Architectural Digest*, 1982, p 182.

2 Shaw's Corner, National Trust pamphlet, 1978, p 3 & 4.

3 Private correspondence from G Fraser Gallie, Custodian, Shaw's Corner, June 24, 1985.

4 Lawrence, D H, ed, *Bernard Shaw, Collected Letters, 1911-1925*, quoted in Time Magazine, July 5, 1985, pp DT 10.

5 Private correspondence from G Fraser Gallie, Custodian, Shaw's Corner, June 24, 1985 and Sept 11, 1985.

6 Crawforth, M A, *Handbook of Old Weighing Instruments*, ISASC, Chicago, 1984, pp 120-121.

7 Crawforth, M A, Geo Salter & Co, *Equilibrium*, p 515-529.

8 Editor- the easy way to differentiate between the top quality scales by Samuel Turner Senior and those by Sampson Mordan is to look directly under the pans. If the leg is straight, it has to be by S Mordan. If it is semi-circular at the top, it is probably by S Turner Senior. Hunt for STS stamped very lightly on the inside surface of the top beams. S Turner did not always stamp the beam, but he often did so.

9 Private correspondence from Michael Robinson.

10 Editor- Inspectors markings would be a sign that the weights had been used on a scale used for trade. Not desirable on a postal scale!

11 The adjustment lug has a slot in it, which gives access for a mechanic's tool, but does not permit adjustment by an amateur.

12 Shaw's Corner, idib, p 7.

Author's Biography

Lew Weiss was an accountant, and his adored wife, Ruth, was a teacher. They form a strong team, that, amongst other things, has contributed very actively to museums, writing, giving talks, and guiding visitors. Their quest for knowledge still persists, in that they go several times a year to Elder Hostels [the American equivalent of the University of the Third Age] and take long tours and cruises with lecturers. They are founder members of ISASC, always keen to learn more about their fine, small scales with which they surround themselves in their sunny apartment.

Showcase

A French scale box, of the style popular in the 15th and 16th century. The parquetry lid was inlaid with ivory, incised with a design of a standing warrior on a hill before a castle, with twisted pillars to each side, and fruit [including the fashionable pineapple grown in the new hot-houses] in the top panels. In spite of a warped lid and a few worm holes, this is a rare and exciting box, because it is so emphatically of its early period.

This came up for auction in the Christie's South Kensington sale on 29th May, 1997, with the other items in this EQM that are annotated "Courtesy of Christie's South Kensington". The editor is deeply indebted to Jeremy Collins for the kindness he has shown in permitting us to use so many of his excellent photographs, when the editor was unable to obtain illustrations due to problems at the last minute of preparation of EQM.

Christie's hold auctions of Scientific Instruments about four or five times a year, usually including 30-130 lots of scales or weights. Many are illustrated in the catalogues available from 85 Old Brompton Road, London SW7 3LD.

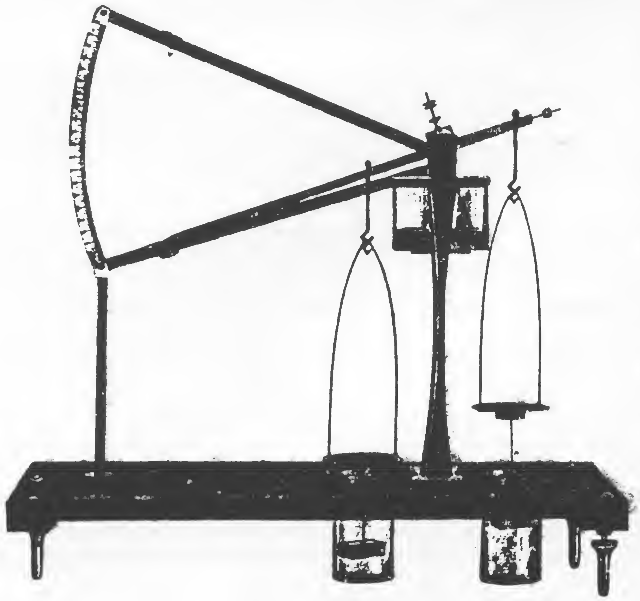
Julian H Becker

By B DONIGER

My quick weighing Quadrant Balance has three oil-dashpots, one paddle-dashpot to slow the oscillations of the beam, and two vertical dashpots, one for each pan! The dashpots are most easily seen in the top border, in the advertisement for the version without a case. The text on the back calls them "a small vane swinging in a vessel".

JULIAN H. BECKER - DELFT (Holland)

TELEGRAPHIC ADDRESS: BALANS-DELFT



QUICK WEIGHING BALANCES

No. 408 Capacity 100 grammes, sensitivity 2 milligrammes.

Complete
PRICE $ 80,— EX WORKS
Codeword: *Olitap.*

Complete with glasscase
PRICE $ 97,— EX WORKS
Codeword: *Tapkast.*

The outstanding feature of this balance is RAPIDITY, which ensures precision and sparing of time.

Ask for our special leaflets. P. T. O.

N.V. BALANSEN- EN GEWICHTENFABRIEK VAN JULIAN H. BECKER - DELFT (HOLLAND)

The balance illustrated on the other side is of the

NEW IMPROVED QUICK WEIGHING QUADRANTBALANCE

The quadrant has a length of about 22 centimeters and is divided into 200 divisions. As the whole quadrant is made to weigh 1 gramme without weights, each division must have a value of 5 milligrammes.

It is clear that if the pointer stops between two divisions, that 2 milligrammes can be easily estimated. For weighings from 1 gramme upwards to 100 grammes brass weights are put on the pan between quadrant and column.

This High Precision Balance is damped by means of a small vane swinging in a vessel with oil attached to the column. The pans are arrested by vanes swinging in vessels with oil, that are put under the pans.

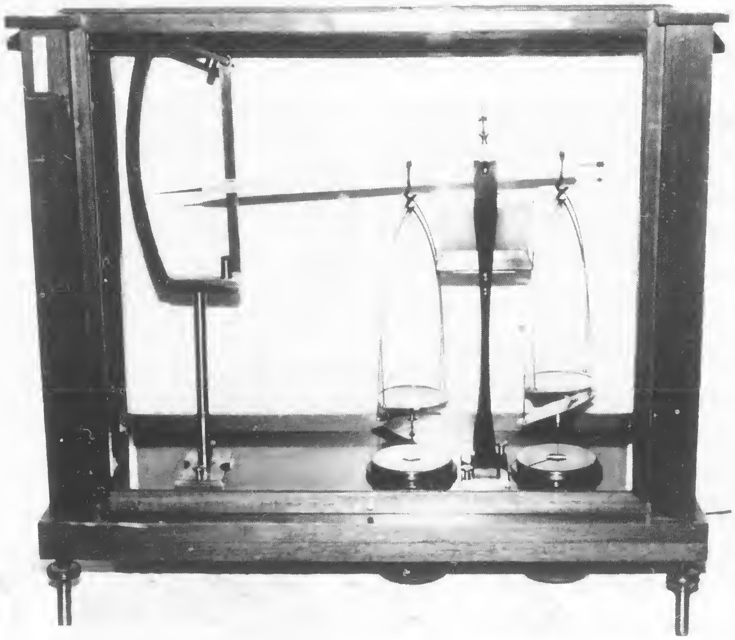
By this construction the pointer stops immediately when the point of equilibrium is reached and it reaches its final position within a few seconds.

This balance, wich is provided with levelling screws and level, has many applications and may be used a.o. for weighing samples in great numbers in a very short time.

In view of the great sensitivity it is advisable to order this balance in a mahogany glasscase with counterpoised frontdoor at . . . . $ 17,— extra.

ADVANTAGES OF THESE BALANCES:

NO USE OF MILLIGRAMMEWEIGHTS.
NO LOSS OF TIME.
GREAT SENSITIVITY.
EXTREME ACCURACY.



Julian H Becker Quick Weighing Quadrant Balance,[1] date unknown. Possibly 1950s.

[The balance has only one beam, but because the case was too difficult to photograph in a large space, the white paper background was directly behind the case, and received a heavy shadow from the beam.]

The use of three dashpots on a precision balance with a capacity of only 100 grammes using the load-pan and added capacity of 1 gramme ($^1/_{28}$ of an ounce Avoir) on the beam, points up the fact that the dashpots did not reduce sensitivity to an impractical degree.[2] J H Becker recommended the use of a glass case, which he would not have suggested if the balance had been for really crude weighing.[3]

Notes and References

1 B J Oliver and A Morris state that Oertling Ltd bought the rights from W A Webb to manufacture a quick-weighing, crude equal-arm beam balance in the 1960s. This was the J 10 that had an oil-damper.

P Buchanan drew attention to The National Physical Laboratory *Notes on Applied Science No. 7, Balances, Weights and Precise Laboratory Weighing*, HMSO, 1962, which has this note:-

Heavy duty balances can be fitted with oil-damping in which the pistons, usually attached to the beam, work in oil contained in the cylinders. The oil should be of appropriate viscosity and should not evaporate. Creepage of the oil sometimes causes difficulty and it may be necessary to treat the metal surface specially to prevent this. The buoyancy of the oil on that part of the piston stem which rises and falls through the oil surface modifies the sensitivity of the balance; the piston stems should accordingly be uniform in cross-section where they pass through the oil surface.

Heavy duty is a relative term! The National Physical Laboratory would consider a balance that had a capacity of 100 grams as heavy duty!

Vandome & Hart Ltd boasted that *Dead accuracy is assured, as all rotating contact parts are Steel Knife Edges and highly polished Agate Bearings, working with patent oil cushion*, when they were only advertising their Arbiter paper scale which had a capacity of 40 lb x ¼ lb!! See EQM p 1704.

2 Most precision balances with oil-dashpots were specified to be for weighing *not below than 1 gram*, as the thin skin of oil on the piston stems would be enough to cause the balance to register a big percentage of 1 gram on one side.

Silicone was used as a substitute for mineral oil sometimes. Can any member give dates for the use of silicone, and tell of its advantages or disadvantages?

3 Quick weighing was desired in many laboratories, when several approximate weighings were needed, and several companies tried the use of oil-filled dashpots. Poynting described liquid damping in 1894.

Although air-damping was first tried by Frederich Arzberger in 1875 (EQM, page 702) it was not generally accepted as a means of slowing the oscillations until the 1930s.

C Becker of the Netherlands used air-damping. Can any member inform us of the relationship between Julian H Becker and C Becker? Can dates be stated for each company?

More Oil-Damping

BY A MORRIS

August Sauter of Ebingen used oil-damping from around 1927, on their highly successful pendulum scales that had a pointer that revolved five times round the dial. To explain in non-scaleman's terms, the load on the platform pulled down the rod going from the platform to the double-pendulum. The rod had a piston rigidly attached to it that moved up and down in a dashpot of oil. The oil seeped round the piston and also up through a little hole in the piston, slowing the movement of the rod.

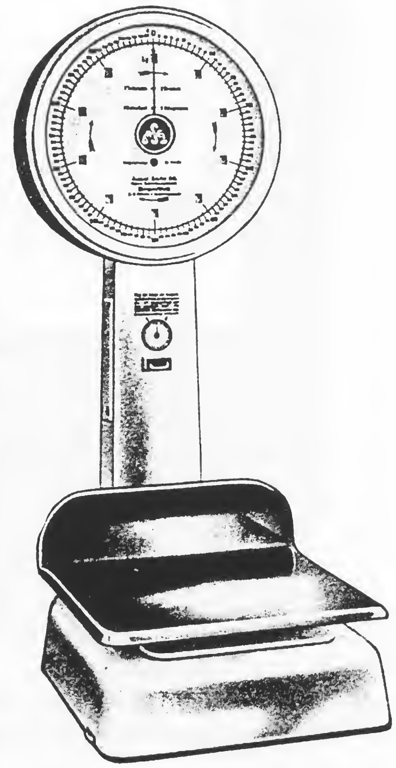
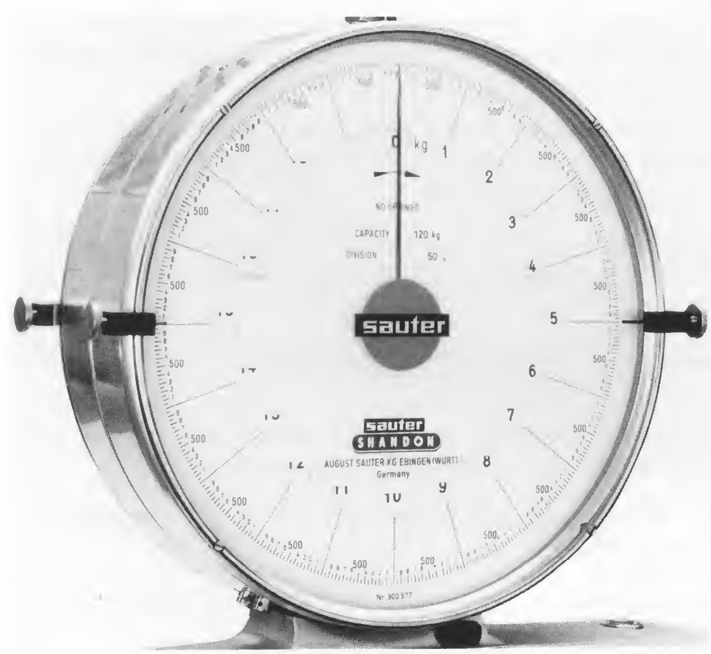


Fig. 1. A Sauter [ASE] c.1960.

The advantage of having a pointer that revolved five times [showing the read-out in little windows] was that the reading line of graduations was over 4 metres (4¼ yards) long, and the divisions of the reading line were well-separated. This was achieved by attaching the graduated chart to the rack, so that it descended with the rack. The user saw the numbers in the windows gradually descend, but he read only the window to the *anti-clockwise* side of the pointer, and added the subdivisions on the dial to the large number in the window. The low capacity versions of this scale, at around 2 kilos, were practical in markets, and the high capacity versions, at around 3000 kilos, were practical in warehouses.

It was possible to use oil-damping in market scales without spilling the oil because various sealing and locking devices were used. The whole mechanism could be screwed down to immobilise it, and thus immobilise the piston. The piston in the damper could be raised to the top of the cylinder, sealing the hole through which the stem of the piston protruded. The piston could have locking glands to be unscrewed before use.

Another company that made scales very similar to August Sauter's was the Italian company Suprema. Many Suprema double-pendulum scales with oil-damping were imported into Britain during the 1970s.



Author's Biography

Tony Morris worked for Oertling Ltd and for Shandon Scientific (importers of Sauter balances) before setting up his own company, European Instruments. His team repaired all sorts of scales, and imported Suprema scales until mechanical scales were replaced by load-cell scales. Recently he decided to upgrade his weight-adjusting facilities to OIML F1 Standard so that fine tolerances can be achieved (to 0.000001g) on the US Troemner weights that he imports in huge numbers. His two metrology laboratories have temperature control, humidity control, ten anti-vibration pillars, positive air-pressure [to push air out, rather than allow dusty air in], anti-static surfaces, and compensation by computers for barometric pressure. Ten ultra-sensitive mass comparators are needed for this work. In the second laboratory he continues to use 3 knife-edge balances. To relax, he cossets his vintage cars and motor-bikes, doing his own repairs, is building a racing car with his eldest son and building radio-controlled model aircraft with his youngest son.

More Oil-damping

BY D F CRAWFORTH-HITCHINS

Gebrüder Bosch showed three precision balances with oil-damping in an undated catalogue [probably of about 1920], List 23, even though the catalogue included balances with air-damping. The text gave little detail about the construction of the balances, so there is only the evidence of the illustrations to help. Figure 1 shows an '*Oil damping device in cast-iron housing completely enclosed to prevent pollution of the oil.*' As the pillar was so enlarged, the assumption must be that the dashpot was behind the pillar, in the centre, with a paddle extending down from the beam.

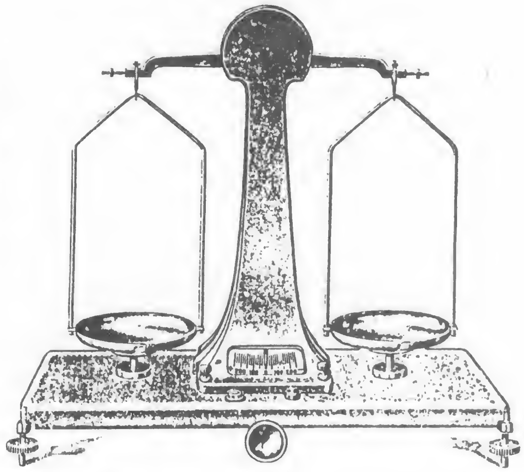


Fig. 1. Gebrüder Bosch, Junginen, c.1920. Precision balance with oil-damping. The smallest version was capacity 250 x 5g, minimum capacity 150mg. Illuminated chart. Height 285mm (11¼ ins).

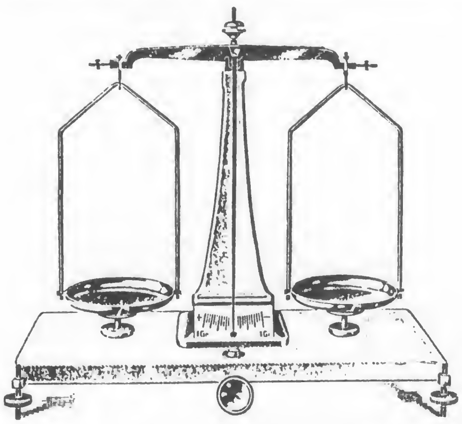


Fig. 2. ▲▲ Gebrüder Bosch, Junginen, c.1920. Precision balance with oil-damping. The smallest version was capacity 250 x 10g, minimum capacity 250mg. Not illuminated. Height 240mm (9½ ins). More exposed, smaller, cruder version of the balance in Fig. 1.

No details are given about the oil-damping of the balance in Figure 2, but it is a cheaper, very similar balance.

The third one was their high-speed scale. Fig. 3.

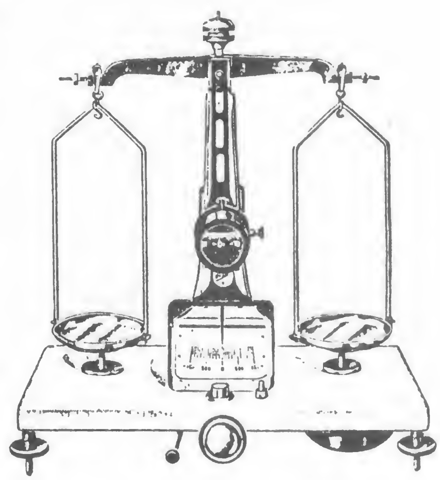


Fig. 3. ➤➤ Gebrüder Bosch, Junginen, c.1920. Precision Speed-scale with oil-damping and projected graduations. The smallest version was capacity 250 x 5g, minimum capacity 1g. Available with glass case. Height 240mm (9½ ins).

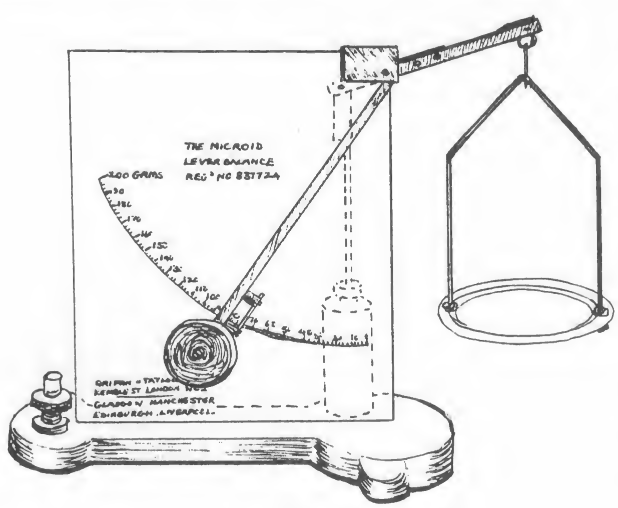


Fig. 4. ≺≺ Griffin & Tatlock Ltd, Microid, c.1940.

Other companies supplied quick-readout scales for use in laboratories and schools. Griffin & Tatlock Ltd, of Kemble Street, London, WC 2, and Glasgow, Manchester, Edinburgh and Liverpool, made The Microid Lever Balance, Reg^{d} no. 837724 [1940]. Height 14½ ins (360mm). It is a rectangle of sheet iron, thinly galvanised, with folded edges to give rigidity. An arc is transfer-printed onto one side, 0-200g. The arm is damped by the extension at the rear, which has a piston into an oil-damper attached to the heavy enamelled base. Hideous, but useful!

Old Advert, 1844

BY J R KATZ

I recently participated in an Ephemera Show, where a dealer colleague of mine approached me with a broad grin and handed me a small envelope. "This is something you'd be interested in, but perhaps a bit pricey", he said. My friend is primarily a dealer in philatelic material, especially Naval cancellations, but does do a rather complete line in collectible paper. He keeps an eye out for me on scale-related ephemera. As it turns out, the envelope was of the type that was actually the letter which, when folded, became the total postal entity. the letter was dated Nov. 12, 1844, and also included the flyer shown here. This was clearly my "bag" and I would have loved to call it mine but that was not to be.

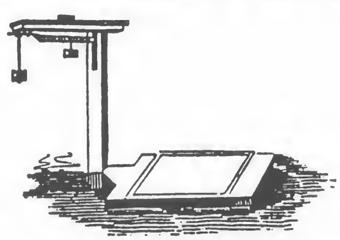
As it turned out, the stamp on the envelope was a first of issue of the Boyds City Express, a private dispatch company in New York City. The envelope was also stamped with a Boyds' postmark. That little package was a $600 piece of paper Americana. My friend did allow me to make a photocopy to share with the scale-collecting community. The extreme philatelic rarity put what was otherwise would have been attainable, out of my reach to add to my collection. I hold nothing in my collection from Gerald the scalemaker, and, what's more, I never came across that name. Clearly he must have been one of the short-lived makers in the early days to join the bandwagon in an attempt to compete with Fairbanks, who was the leading US player at that time, Fairbanks having been founded in 1830, and moving along, by 1844, with a great deal of success. Anyone have any information on Gerald?

GERALD'S

PATENT PLATFORM SCALES

MADE AND SOLD

No. 120 **New York, &**



Barrow Street, **Warranted.**

The proprietors having spent considerable money and time have succeeded to their entire satisfaction in perfecting a weighing apparatus which they offer to the public as being the cheapest and best Platform Scale ever invented. Their simplicity of construction—their durability—their accuracy and adaption to the different purposes for which they are designed are superior to any other ever manufactured in the United States or Europe.

Hay Scales, Coal Scales and other Scales suitable for weighing Cattle, Hogs, Sheep, &c. made at the reduced prices, from $30 to $80.

Rail Road Scales built in a superior manner both for accuracy and durability at prices to suit the times.

Dormant and Portable Platform Scales, suitable for Groceries, manufactories, Flour Mills, Tow Boats and other Vessels carrying Freight necessary to be weighed and for all common uses, and made in shape and size to suit purchasers.

Trusting for success to the superiority of their Scales in simplicity of principle, durability, accuracy and workmanship, they respectfully suggest to those who may be in want of a genuine article, the propriety of examining or employing some skilful mechanic to examine their scales before purchasing.

☞ *Scales removed and repaired. All Orders will receive prompt attention.*

ISASC

EQUILIBRIUM®

QUARTERLY MAGAZINE OF THE INTERNATIONAL SOCIETY OF ANTIQUE SCALE COLLECTORS

1997—ISSUE NO. 4

PAGES 2169-2196

Cover Picture

This anonymous spring scale is triple purpose. As shown, a person can stand on the platform, and bend over to read the dial between his toes, using the outer graduations printed in black, as a *Personal Scale*. The dial has hinges and a chain connecting it to the roberval linkage, so that the dial can be pulled up into the horizontal position for use.

Secondly, the scale can be put onto a table, the dial can be pushed down into the vertical position, a parcel put on the platform and a person can read the dial from in front, using the inner set of graduations printed in red as a *Luggage Scale*.

Thirdly, the two handles on each side can be squeezed together and the force can be registered, so the scale should be called a dynamometer when in this mode. It can be used to strengthen the hands and arms. Presumably the scale is held in front of the body while doing the squeezing, and the scale is lifted up and forward to develop the muscles in the back. The same company also made the scale without handles so without the dynamometer function.

This type of step-on platform, directly above the spring mechanism, obviated the need for levers, (referred to by Scheurer on page 2181) because the pressure of the platform worked directly down two rods to the bottom cross-piece which pulled down two rugged springs.

Several variations on this theme have survived, all 20th century and mostly anonymous. The earliest of these compact person scales seems to be the F Koch patent of 28 May 1910. Johannes Lindner is researching these scales and we look forward to reading about them in the future. Courtesy G and A Renton

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Associate Editor - - Ruth Hendricks Willard, P.O. Box 27565, San Francisco, CA 94127, USA.

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Edme Régnier

BY A POMMIER & A J SIMCOCK

In reponse to the request for information on Edme Régnier , EQM, p 1869:

Biography

Edme Régnier, (sometimes called Regnier), mechanical engineer, was born in 1751 in Semur, Côte d'Or, France; and died in Paris in 1825. Before the French Revolution he was a gunsmith in Semur and during the Revolution, he was inspector for the manufacture of portable weapons (1793-1794). Régnier was made the Overseer of Models and Archives of Artillery, became a collector of old weapons which formed the basis of the Museum of Artillery, and eventually he became the Curator of the Museum.[1]

He invented or improved sixty-five commonly-used instruments, including secateurs, a combination lock, a fire-escape and particularly dynamometers.[1] He wrote about *Cannons*, and in 1798, about *Dynamometers....invented by Citizen Regnier.*[2]

In its report, the Jury for the Paris International Exhibition in 1819 (August 25 to September 30) says: *Régnier, Ingénieur-mécanicien, Rue du Colombier 30, Machines diverses de précision (dont dynamomètres)*.

Owners of this V-spring

The Musée national des Techniques (CNAM, Paris) has an example (Fig. 1) of a *Peson à ressort* (V-spring) manufactured by Régnier.[3] This *peson* was amongst the objects found in the laboratory of the chemist, Lavoisier (1743-1794). An inventory of these objects, written by McKie, notes about this V-spring: *Simple spring-balance, merely an angle of wrought iron with brass scale reading from 0 to 120, weight being given on scale by the bending against the scale of the movable arm of the angle.* Lavoisier was Inspector of Gunpowder from 1775 and lived with his chemist wife, Marie-Anne Pierrrette-Paylze, in a famous house at the Arsenal until 1792.[4] The reason for his being guillotined in 1794 had nothing to do with his work as Inspector of Gunpowder, but was precipitated by his work as a Farmer of Taxes, to which the Revolutionary Courts took exception.

Comments by Aimé Pommier, (translated by D F C-H)

I think that this *peson-dynamomètre* was made about 1793-1795. The type of units, (0-120), are not indicated on the scale, but they are probably in Livres de Paris.

The brass arc is stamped with the mark **ER**. Between the two normal arcs is mounted a curved shaft bearing a disc of felt showing evidence of wear.

I think that this model of dynamometer was used to test gunpowder; at one corner it was attached to a fixed point, at the other corner there was a little container holding a measured quantity of gunpowder. After the explosion of that powder, the place to which the felt disc had moved indicated the precise force taken by the dynamometer during the explosion.

Fig. 1. *Peson à ressort* (V spring scale) 193mm (7¾ ins) high, iron with brass arc for graduations, graduated 20-60-90-100 and 120. Stamped **ER**.

Courtesy A Pommier & CNAM

Comment by D F C-H

If Lavoisier, the Inspector of Gunpowder, owned this dynamometer, this gives credence to Aimé Pommier's idea that this instrument was for testing gunpowder, but usually instruments associated with gunpowder were made purely of brass, to reduce the risk of sparks causing explosions at the wrong time. Arsenals

ordered special equipment made of brass, wood or other non-sparking materials.

However, another function is feasible: the testing of the amount of pressure needed to fire a gun. Such an instrument would be attached to the trigger by a string, pulled taut. As the trigger was pulled, the felt disc would be moved along the shaft, only stopping when the pressure on the trigger stopped because the gun had fired. These instruments were not necessarily made of brass, as they were used without the gun's being loaded. These tension-testers were widely used within the gun-trade, as the pressure needed to fire a gun was important: too light and the gun might go off inadvertently; too heavy and the gun might not go off soon enough in a dangerous situation. To resolve this interpretation of function, Regnier's publication on Dynamometers needs to be consulted.

Missing Fittings

For a conventional V-spring scale, there would be an iron ring attached to one corner, by which the scale was held and a hook descending from the other corner, to take the load.

As this was adapted to being a dynamometer, there must have been facilities to attach the V-spring firmly to the object being tested. On more recently-made trigger tension-testers, the dynamometer had a strong cord forming a loop that could be slipped round the trigger. Another cord formed a loop at the other corner, which was braced by the fingers of one hand, while the gun was pulled away from the dynamometer with the other hand until the trigger went off.

For testing gunpowder, the user needed a system that moved the force of the explosion directly away, in line with the arc being described by the pointer, so that the two arcs passing each other did not get forced sideways, and rub against their guards. This could be achieved by rigging up a frame that kept the container of gunpowder vertical so that it was not spilled out before being tested. The piston forced out of the container would be fixed rigidly to the corner of the V-spring, pulling the V-spring shut.

Inventor of C-spring scales with rack and pinion?

If the note at the Avery Historical Museum is correct, and Regnier did invent an elliptical spring scale he could not have thought of it before Hanin in 1765, as Regnier was only eleven years old when Hanin was applauded (see EQM, p 1865). Possibly a search of French patents would turn up another idea by Regnier, based on a C-spring scale, but that is not the same as being the inventor.

Notes and References

1 Alphandéry, M-F, *Dictionnaire des Inventeurs Français*, pub Edition Seghers, Paris, 1962.

2 Poggendorff, J C, *Biographisch literisches Handwörterbuch zur Geschichte der Exacten Wissenschaften....*, vol. 1, Leipzig, 1863, reprint B M Israël, Amsterdam, 1965.

3 CNAM, inventory no. 19.895.

4 Williams, T I, ed., *A Biographical Dictionary of Scientists*, pub. A & C Black, London, 1st ed. 1969.

Author's Biography

Aimé Pommier started *Le Système métrique* for the Société métrique de France in 1982, after the small Newsletter proved inadequate. He often wrote the bulk of each issue, until he enthused other contributors to share their knowledge, and is particularly respected for his publication with Marc Roblot of long lists of French scale- and weight-makers from 1789-1914. He works with his charming wife, Pierrette, taking superlative photographs and writing clear, explicit articles, books and catalogues, particularly in association with the CNAM [Conservatoire National des Arts et Métiers, Paris]. He wrote the books *L'aventure du mètre* and *Inventaire des poids.*

Tony Simcock worked at the industrial Gladstone Pottery Museum in Stoke before becoming the Librarian of the Museum of the History of Science, Oxford. His knowledge of the contents of the books in his charge is phenomenal, enabling him to give instant help on the most obscure matters relating to instruments. He edited the 3rd edition of *Beeson's Clockmaking in Oxfordshire*, in 1989, edited *Poets' England 6; Staffordshire*, in 1986, edited and wrote *Robert T Gunther and the Old Ashmolean*, in 1985, and wrote *The Ashmolean Museum and Oxford Science 1683-1983*, in 1984, and has had many poems published.

The Science of Weighing Yesterday

Part 2

BY W A SCHEURER

Illustrations found by, captions composed by, and footnotes inserted by D F Crawforth-Hitchins

Editor:- The first paragraph below refers to units and divisions that appear in no other reference books owned by the editor, and the next four paragraphs should be treated as a romantic personal interpretation by W Scheurer.

Around 850 AD, Alfred the Great brought considerable uniformity to the standard weight units of England. The prevailing English measure of capacity was a container one hand-breadth long in each dimension. The weight of water filling this container became the basic weight unit: the Measure Weight. The set of derived units then was: one Tun Weight equalled 1000 Measure Weights; one Measure Weight equalled 1000 Skeats; One-half Measure Weight equalled one Scale Weight; one Hundred Weight equalled 100 Scale Weights;[1] the Half-Hundred Weight equalled 50 Scale Weights; and the Stone Weight equalled $^1/_8$th Hundred Weight.

A Revolution: The Prototype Standard

At this moment in world history, a great step was taken towards more accurate weight standards. Rather than each English community constructing its own basic weight unit by rough guess, it borrowed the national standard from the royal government and made an exact duplicate of it in iron. As far as we know, this is the first instance of what might be called the Prototype Standard. The standards were carefully kept, by order of the Saxon Kings, at Winchester. After the Norman conquest in 1066, William the Conqueror determined to preserve the Anglo-Saxon system of standard weights and had the prototypes moved to Westminster Abbey.

The recognition of the need for standard units of weights and measures was so great that the famous Magna Carta of 1215 stressed the principle of uniformity. Somewhat later, Henry III redefined the traditional Saxon monetary unit of the pound, known as the *pound sterling* because the English penny was called a *pence sterling*. The ratios were: one pound=20 shillings; one shilling[2]=12 pence; the system still used today.[3] Also, 20 pence=one ounce and 12 ounces=one pound.[4] The English pound sterling had the same divisions as the livre esterling of Charlemagne, unifier of Europe in the 9th century.

In 1303, when London had become one of the great trading cities of Europe, the London merchants were empowered to install a new pound weight system, consisting of 16 ounces to the pound, and called *aver-de-peis*, meaning *weight of goods* (later corrupted to its present form of avoirdupois). It was not from intent but from coincidence that the new English pound nearly equalled the weight of the Italian pound, called the libra; and the English ounce was almost identical in weight to the Italian Onzia, the Italian system having been derived from the Roman.[4] This is why today our abbreviation for the pound is lb and oz for the ounce.

Fig. 1. Nürnberg nesting weights

Even before the introduction of the avoirdupois system, many English port cities were using another set of units for weighing precious metals, jewellery, and drugs.[5] This was the Troy system used by the Hanseatic League of North Germany and Baltic cities which was rising to a dominant position in maritime commerce. Exact weight was so important to Hanseatic trade that its scales were specially made in Nurnberg,[6] and the set of weights was based on the German onze, or Troy Ounce. The Troy system itself may have taken its name from the town of Troyes in France, center of the great Champagne Fairs, most famous of all medieval European trading regions.

The Hanse maintained outlying settlements in four big cities, one of which was London. This part of the city was called the *Steelyard*. It is not known whether it took this name because of the metal-loading docks, or because of the huge steelyard used to weigh heavy goods. [See EQM, page 1246.]

The Londoners referred to these German traders as *Easterners* or *Easterlings* - later shortened to *Sterlings*. Consequently, the Luebeck coins were called sterling silver; the ounce was the sterling ounce; and the pound was the pound sterling.

In the 19th century, the Troy system [pound] was abolished in England, with the exception of the Troy Ounce of 480 Grains, used to weigh precious metals and stones.

The Great Metric Revolution

Following the westward course of the history of weighing, we observe a continuation of the same two trends which have threaded the whole development of weight standards; 1) The constant rise of different sets of standard units, often resembling each other, and 2) the tendency to simplify the number of units by the direction and control of a central government. Yet the only significant advance towards the goal of increasing accuracy was the English establishment of a prototype standard, and its duplication by the various communities throughout the country.

While this was an epoch-making improvement, it did nothing to establish a universal system to be used throughout the world by all peoples. Moreover, like almost all other systems of the past, its units involved fractions. What was needed was a system in which weights, measures and volumes were immediately related by units which were always the same fraction or multiple of a single base unit.

Of all the upheavals occasioned by the French Revolution of 1789, the most important for the history of weight measurement was the invention of the metric system. This system, adopted by France in 1790, was the first plan ever to relate measure, weight and volume by the same units, each of which was the same multiple or fraction of a base unit. This basic standard was named the metre (from the French *to measure*) and the derived units were decimal multiples or fractions of this standard unit of length. The metre was defined as one ten millionth of a quadrant of the earth's circumference.

The exact length of the meter was to be determined by measuring the difference in latitude between

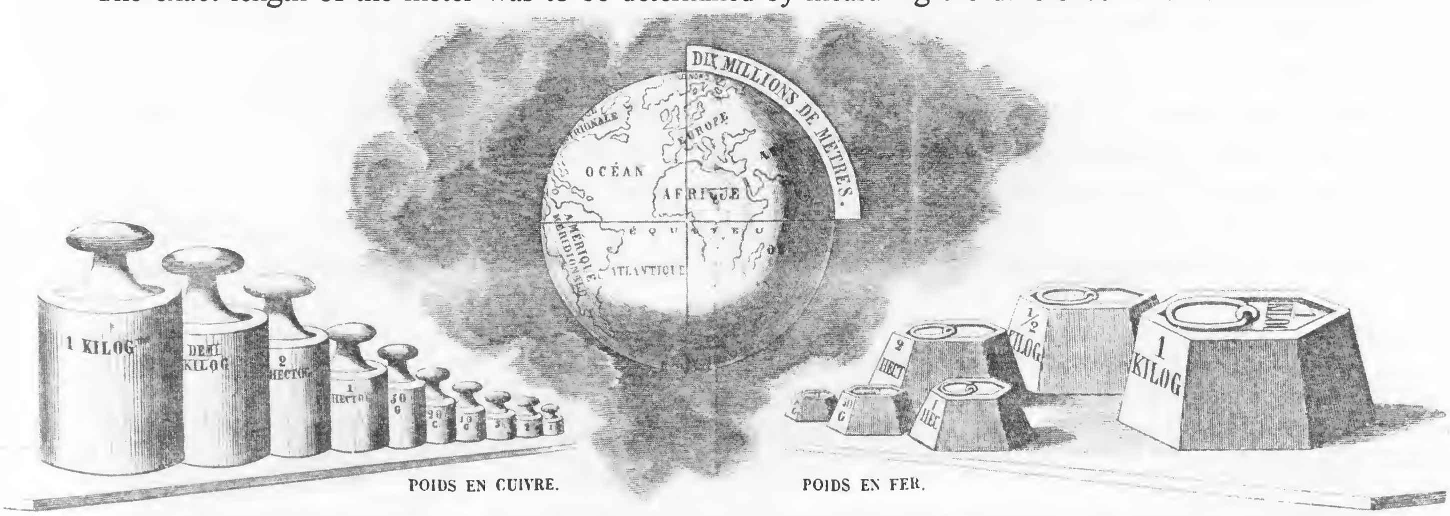


Fig.2. From an educational sheet printed in France in about 1850. The brass weights on the left were made to the compulsory design of a plain cylinder with a knob on top. No other design was permitted for brass weights. The iron weights on the right were of the compulsory design for iron weights under 10 kilos; hexagonal, with a recessed top, to protect the raised figures of 1 KILOG and to protect the ring that was recessed into the depression so that the whole ring was below the surface of the edge. Thus the weight put on top could not abrade the weight below. This sensible uniformity put an end to the delightful variety of weights previously made in France.[7]

Courtesy B Silverstein

Dunkirk, France and Barcelona, Spain. After that was done, a standard meter bar was constructed. However, due to slight error, it was found that the distance on the earth's surface from the Equator to the North Pole was not exactly ten million units of the new meter, but slightly more. But it was now too late to change the system. (See Fig. 2.) In 1875, the International Bureau of Weights and Measures was established, and prepared a platinum-iridium alloy bar on which two fine marks were made, the distance between them defining the standard length of the meter. This International Prototype Meter is kept at Sevres, a Paris suburb, and exact copies of it, called National Prototype Meters, are in the possession of governments of various countries.

To a great extent, the Metric System marks the fulfillment of man's long search for a universal standard of weights and measures. It is an invention almost as significant as the weight itself.

Weights in the United States

The systems of weights and measures in the United States are similar to those of Great Britain, with some variations. A resolution of Congress in 1836 approved the units adopted by the Treasury Department in 1832, which endorsed the avoirdupois pound of 7,000 grains. While Congress has never actually adopted these standards, they are in general practical use throughout the country. Congress further stipulated that each of the States was to be supplied with a complete set of weights and measures. This was accomplished by 1850. This set also included the troy pound of 5,760 grains.

In 1866, Congress approved the use of the metric system in the United States without, however, making it the standard. Thus both systems are in wide use throughout the country. The ounce-pound system is in general use in commerce and industry while the gram-kilogram system is increasingly used in science and technology. It is a curious fact that even today in the vaults of the National Bureau of Standards there is no national prototype avoirdupois pound. But there is a national prototype kilogram.

The National Bureau of Standards

Symbolic of the westward course of scale and weights evolution is the rise of the United States National Bureau of Standards. Once merely the custodian of standard prototypes, it has grown to become perhaps the world's largest scientific research centre and testing laboratory. Its huge new complex of buildings near Washington, D.C., houses a whole population of scientists, engineers, technicians and administrators who are living witnesses to the fact that ours is an age of technology - and that technology is founded on accurate standards.

The Evolution of Scales

We return now to pick up the thread of that other great history, the evolution of the scale, or weighing machine. We shall attempt to trace here those revolutionary turning points which have dramatised this history and brought forth an evolving series of ingenious developments. We must distinguish between refinements and the discovery of new principles.

We have already pointed out that the equal arm balance continued to be the only known weighing device for at least 5,000 [years], until Roman times. This does not mean, however, that it retained its original form. Throughout these five millennia a host of refinements greatly increased the accuracy and convenience of the beam balance.

Refinements in the Equal-Arm Beam Balance

The first balance was hand held and pivoted on a knotted cord in a hole at the center of the beam. Or, it may have been suspended from an upright pole. It is also probable that baskets were used to hold the loads.

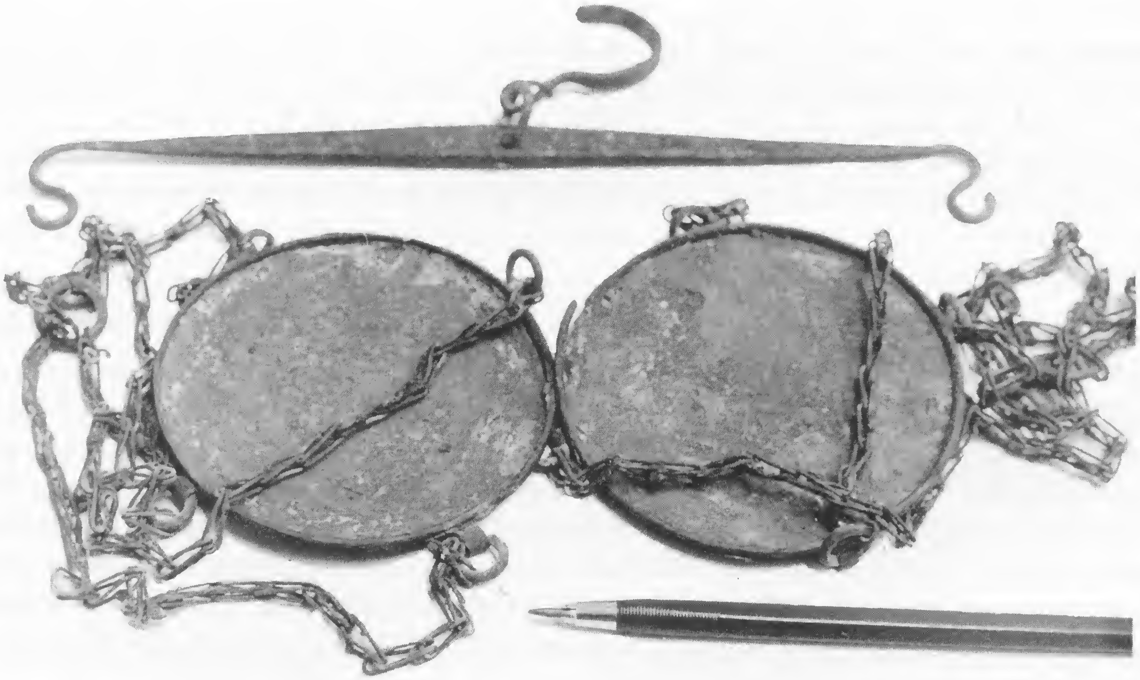


Fig. 3. Roman beam about 7 inches (177mm) long, with beam ends formed by stretching the iron and curling it down into crude hooks. The low position of the hooks caused the beam to be ultra-stable, (fast) and liable to drop heavily on the side it first moved down on. The fulcrum is, in effect, the dowel about which Scheurer talked, but curled round into a ring by which the suspension hook was attached. Science Museum, Wellcome coll. Photo M A Crawforth

These early balances could perform the two basic scale functions: 1) adjusting the unknown load to match a predetermined weight, or 2) determining the weight of any load by adding weights of successively smaller or larger units.

Two significant refinements increased the accuracy of the early balance. One was the method of running the cord out of the ends of the beam so that they always lay flat against them. The use of the *lotus-ended* beam appeared in Egypt about 1500 BC. [See Fig. 4 and 5.] A second refinement was replacing the cord pivot at the fulcrum by a dowel through the centre of the beam, and at right angles to its plane of rotation, preventing wandering. In some cases, the dowel became a rod supported by two upright posts to give greater stability and accommodate much heavier loads. [See fig. 3.]

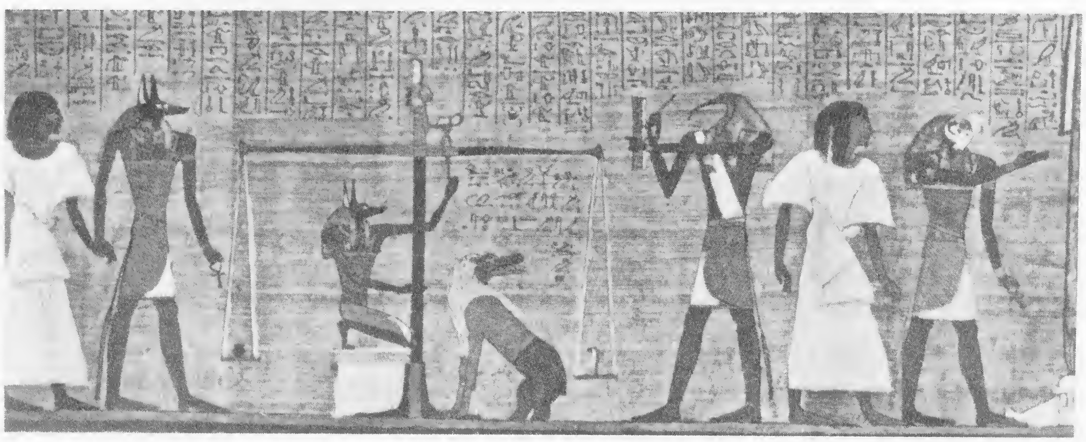


Fig. 4. The weighing of souls, from *The Book of the Dead*, c.1350 BC. The heart of the deceased was balanced against the ostrich feather of truth. Anubis is putting his hand up to the indicator, which appears to be a ring through which the beam passes. The ring would prevent the beam from tipping too far, and make it simple to judge when the beam was horizontally located within the ring.

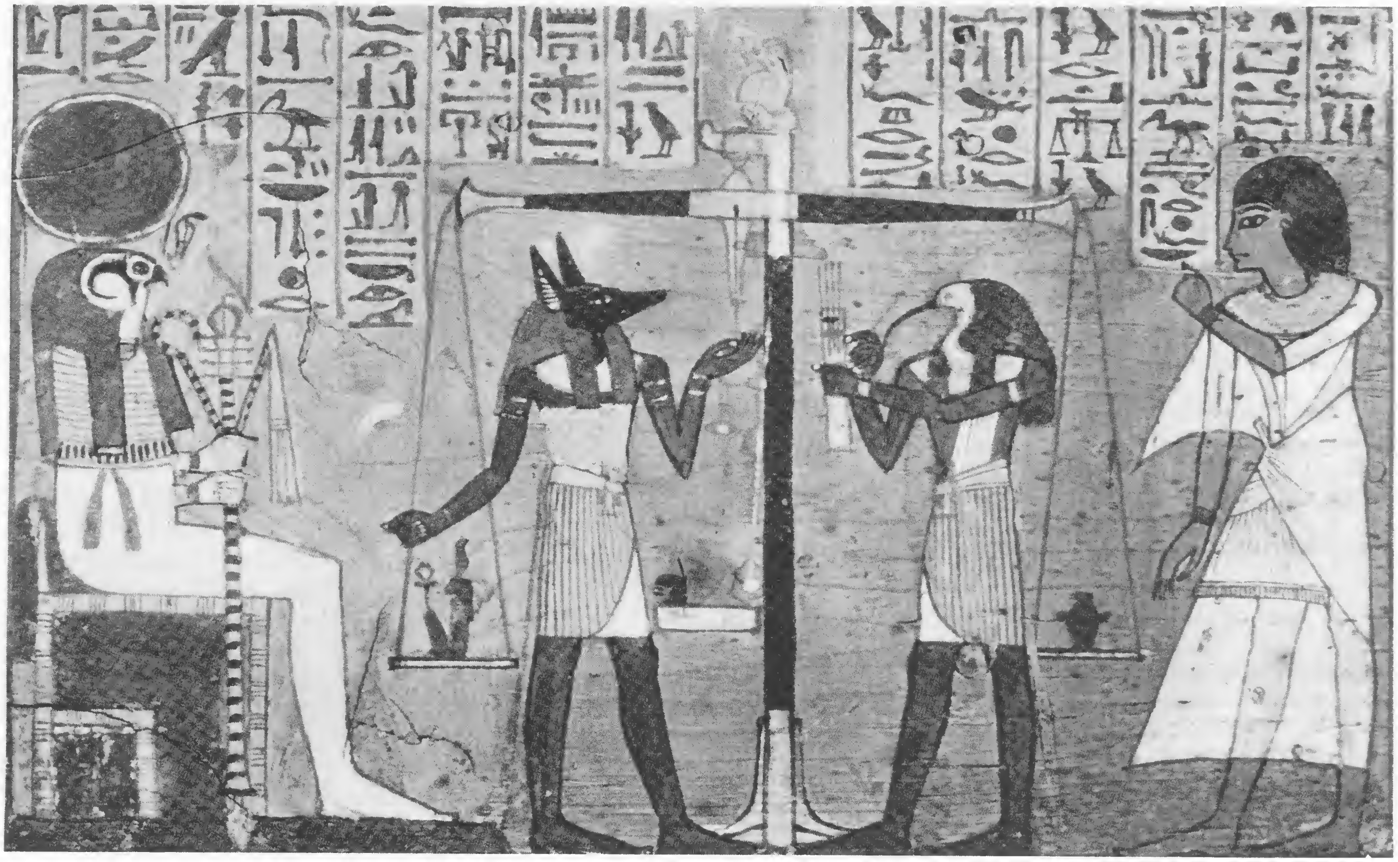


Fig. 5. Painting on a funerary casket of the 26th Dynasty (around 650 BC). Anubis is symbolically weighing the deeds of the dead man. The plumb-line descends down to the hand of Anubis, who was frequently depicted holding the bob. The pointer attached to the beam shows as a white elongated triangle behind the plumb-line.

The accuracy of the equal-arm balance depends on the central pivot being exactly half-way between the beam-end suspensions, and also on there being the smallest possible area of contact between the fulcrum and the beam in its plane of rotation. Furthermore, for a state of equilibrium, the fulcrum must be above the center of gravity of the beam, thus ensuring maximum sensitivity.

The First Indicating Scale

The next advance in scale history was the improvement of the readout by an indicator. Egyptian wall paintings and bas relief show a small tongue hanging down from the center of the beam and perpendicular to its longitudinal axis. A short plumb-line and plumb [bob[8]] shows that the scale is in exact balance when the indicator tongue is coincident with the plumb-line. [See fig. 5.] Another device was a plumb [bob] suspended by three cords. When the beam was balanced, all three cords were taut; when it was out of balance, either of the outer cords would become slack. [See EQM, page 578.]

The Coming of the Unequal-Arm Beam Balance

For thousands of years the equal-arm balance was the only scale in use throughout the world. The increased use of metal provided sturdier and more accurate beams, but the principle remained the same.

Sometime around the birthyear of Christ, there appeared the first new scale principle, the steelyard. The steelyard has its equivalent in the ancient Danish bismar, and there are no records to show which came first, or indeed whether the Greeks or Romans invented the steelyard. [See EQM, page 2144-2145.]

The steelyard is based on the principle of equal moments. A scale beam is, after all, a lever and the principle of a lever is that of a force acting through a distance. This product of force times distance is called a *moment*, and if the sum of two moments is equal, the system is in equilibrium. For example, a two pound weight five feet from the fulcrum will exactly balance a ten pound weight one foot from the fulcrum (2 x 5 = 1 x 10).

The steelyard also used for the first time the principle of the sliding counterpoise. This eliminated the need for pans. [Ed.- weights?]

The great advantage of the steelyard was the ability to weigh very heavy loads by [using] much smaller weights. The beam of the equal-arm balance is a simple lever, with a ratio of 1:1. The steelyard beam, however, is a multiplying lever and, in the case given above, the ratio is 5:1.

The Danish bismar uses the basic steelyard principle except that here the weight, or load sensor, is fixed while the fulcrum is moved until the beam is balanced.

Fig. 6. Steelyard, with moving saddle on which is mounted the load hook and the suspension handle. Scheurer called this type a 'Danish skale', but did not say where he got this name.

In addition to the load-hook there is a pan fixed at the end of the beam, which could enable the instrument to be used as a bismar with a sliding fulcrum. When this photo was taken the graduations were not recorded. Were there bismar-divisions on one side of the beam, and steelyard-divisions on the other side? The divisions for a bismar get closer together as the load increases whereas the divisions for a steelyard stay at the same distance apart as the load increases.

This saddle-type is known to have been used in Scandanavia towards the end of the 19th century, superseding the bismar. A similar scale, dated 1895, was sold recently. Is this a transitional design between a bismar and a steelyard?

Steelyards with a saddle were also used in the 20th century, until at least the 1950s, in Greece and Turkey.

P Riedinger collection

The Danish skale, which came into use somewhat later, is a type of steelyard in which the beam was notched on its underside and could be moved into different positions over a knife-edged pivot, thus changing the ratio, or multiplication factor.

The steelyard marks another significant advance towards more accurate readout. It became customary to cut notches along the top of the weight side of the beam to set the weights [poise] for predetermining the required load. This was the first calibrated readout even though it was probably not originally marked with numbers. [See EQM, page 2144.]

Great Revolution: Self-Balancing & Self-Indicating Scales

The evolution of scales throughout history parallels those great advances in technology and the expansion of commerce. The first refinements of the equal-arm balance were made by the Egyptians at a time when they were rapidly becoming the first great world empire and their commerce had spread throughout the Near East and as far as Crete in the Mediterranean.

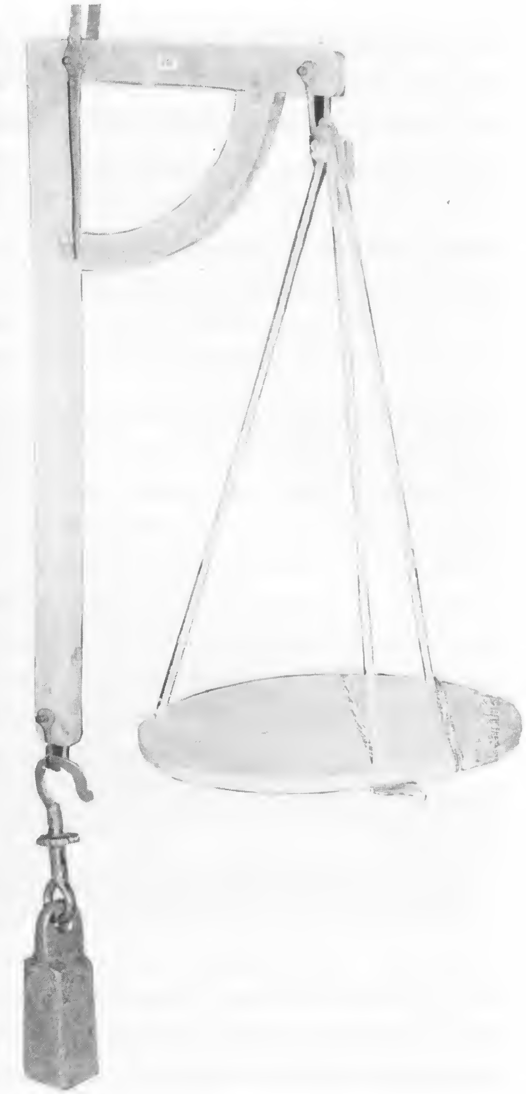


Fig. 7. >> Pendulum scale by an unknown maker, made of wood, with nicely-made iron poise. It might appear overly economical to use wood, but many nations in Europe had to resort to the use of wood when metals were in short supply. Many beautifully-made wooden scales survive, particularly decimal scales, but also coin rockers, postal and trade steelyards, equal-arm beams and some other oddities. Note that the poise is pivotted, so that the arc described by the poise is less than the arc described by the arm from which it hangs. This affects the graduated divisions. Courtesy Bizerba Museum

Similarly, the steelyard appeared at a time when the Graeco-Roman civilisation was rising to dominate the known world, and Greek and Roman commerce had expanded to include a great part of Europe as well as the Mediterranean and the Near East.

The Danish bismar was in use at a time when Denmark was a dominant force in the north, and had conquered Ireland and ruled a large part of England for two hundred years in the 9th and 10th centuries.

And now again a great new principle of the scale was discovered, by an Italian at a time when Italian commerce dominated all European markets and the Renaissance was in full flower. It was perhaps about 1490 that Leonardo da Vinci, probably the most universal talent in the whole of history, designed the self-balancing, self-indicating scale.

In the self-balancing scale, the load sensor automatically balances the load without the necessity of moving or adding weights by hand. Leonardo's scale took two forms, but both operating on the same principle. In one, a semicircular disk was suspended from an upright post by means of a pivot at the center of its diameter. A weight suspended from one corner of the disk causes it to rotate, thus gradually increasing the mass opposing the load. Rotation stops when both masses are balanced. Another design uses a triangle suspended from its apex, and the load suspended from one corner of the triangle base. In this case, the load causes the triangle to rotate about the pivot in the same manner as the semicircular disk.

Fig. 8. Da Vinci's design.

Leonardo had discovered the principle of the pendulum-resistant scale which was to become so widely used in future centuries. For both the semicircular disc and the triangle behaved as pendulums.

Just as significant as the self-balancing principle was its corollary, the self-indicating readout. Leonardo marked the arc of the disk and the base of the triangle with a calibrated scale to show the amount of rotation caused by the load, to give an immediate indication of its weight.

Leonardo's great contribution to the science of weighing was not put to practical use for nearly 400 years, [see EQM, pages 601-609,] and he never built a model of it. It was just another sketch among hundreds in his famous Notebooks. Quite recently working models were made from the sketches, and they operated perfectly. And so this revolution in the art of the scale was just a paper revolution. But the self-indicating scale is today probably the most widely-used of all scale types, with the possible exception of the equal-arm balance found in laboratories.

The Knife Edge - Key to Accurate Balance

The next significant advance in weighing devices probably occurred near the time of Leonardo's invention. This was the use of the knife edge in both the central pivot and the beam ends of the equal-arm balance. The wooden wedge supporting the beam of the ancient Danish scale was an early use of the knife-edge principle.[9] But a steel balance employing knife edges is first seen[10] in a painting [done in 1532] by Hans Holbein in his portrait of George Gisze, a Hanseatic merchant [of the London Steelyard.] Holbein's painting was so detailed and accurate that a working model was constructed from it and is now in the famous Avery Museum in London. [Ed. - Birmingham.] The metal equal-arm balance with knife-edge pivots is still the most accurate of all weighing devices. It is limited primarily by the exactness of the readout (which can be resolved by optical or electronic instrumentation) and the fact that so much time is required for the beam to come into balance after its oscillations.

The Next Step: Roberval's Mechanical Linkage

5,000 years elapsed between the first known equal-arm balance and the appearance of the steelyard. And another 1,500 years passed before the invention of the self-indicating scale. But the time between new inventions was becoming shorter, and 200 years after Leonardo's invention, the Frenchman, Gilles de Roberval brought forth another new scale principle, a mechanical linkage equal-arm balance, known in his time as the *static enigma*.[11] Here two parallel equal arms, each pivoted at their centers to an upright post, are joined at their beam ends by vertical rods to form a parallelogram. Fixed to each vertical rod is a horizontal bar, one of which carries the load and the other the weight. This development had two great advantages: 1) the load and the weight could be suspended at any point along the rigid horizontal bars without changing the equilibrium of the scale, and 2) the load and weight bars always remained in a horizontal position, no matter how far they were raised or lowered.

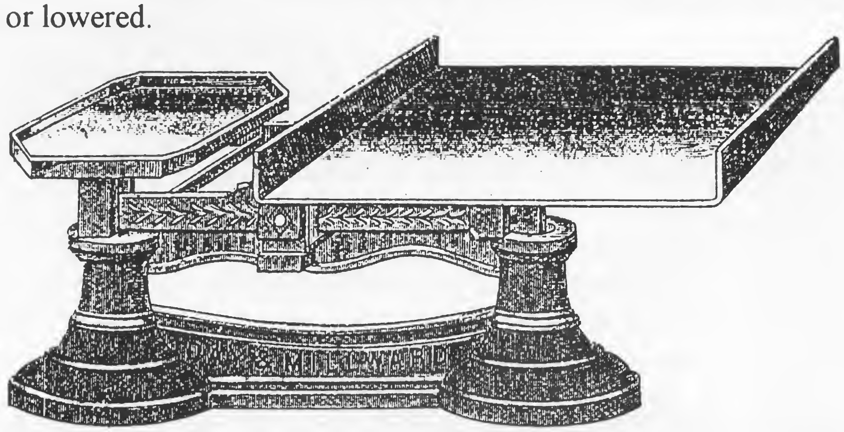


Fig. 9. Day & Millward catalogue 1889, agate weighing machine with suspending beam & Patent Agate centre bearing, capacity 7 lbs, and up to capacity 112 lbs. Roberval scales with accelerating beam. By 1889, Day & Millward were emphasising their vibrating roberval scales. See EQM, p 1637-42.

Roberval's balance opened the way for the familiar counter scale in which the pans are above the fulcrum, eliminating the need for chains and swinging pans. [See EQM, p 1352.]

Roberval's ingenious invention suffered the same fate as Leonardo's self-indicating scale, for it was not put to practical use for more than 150 years.[12] After the beginning of the 19th century, however, it was adopted as the basis for all counter scales.

In the middle of the 19th century, a French scalemaker, Joseph Beranger, devised a scale consisting of a complex system of levers which provided each pan with four points of support, increasing the stability and accuracy of the system.[13]

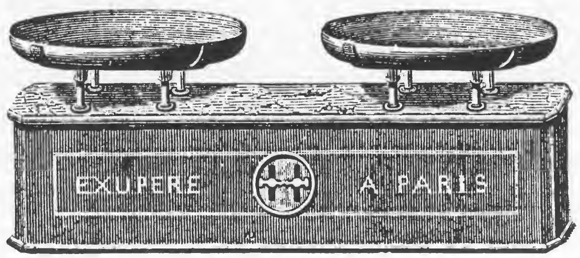


Fig. 10. << Maison Exupère à Paris, (Aubry & George), catalogue c.1927, Balance Pendules, système Béranger. Wooden box, imitation ebony, with white marble cover. Alternatively, supplied with a china box. Capacity 1 kilo, up to capacity 30 kilogs. Pans' diameter up to 13 ins, (135mm).

Courtesy F Wallis

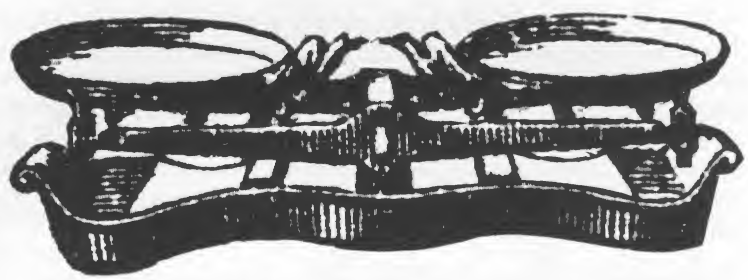


Fig. 11. >> Fairbanks 1859 catalogue included 3 Beranger scales only 12 years after they were invented. Beranger scales were normally covered, as the complex linkages were very difficult to clean, and they commonly had four legs supporting each pan.

The Spring Balance

About 100 years after Roberval invented the mechanical linkage there appeared one of the simplest of all self-indicating scales, the spring scale. Just as the pendulum offers increased resistance against the load as it is displaced, so the spring increasingly opposes the load until both come into balance. When the spring is extended, a pointer fastened to the load end automatically indicates the weight on calibrations on the chart.

There are many varieties of spring scales besides the one developed by Salter in 1770, Sector, Mancur, Stebe, elliptical, and a spring scale with circular readout. [See Cover Picture.] The circular reading face permits several sets of weight calibrations to be arranged in a concentric fashion so that as the spring is extended the dial pointer makes one revolution for lighter loads and more revolutions for heavier loads. The spring is also widely used in conjunction with level [lever] systems, an example being certain types of personal-weighing scales.

Editor:-Due to unsubstantiated statements in this part of Scheurer's paper, the editor is not accepting any letters to the editor relating to the content of this part. This section is published to complete W Scheurer's document, which does give the broad sweep of metrological developments in a very digestible form.

Notes and References

1 These decimal divisions are unexpected, given the surviving evidence.

2 The shilling was a notional unit of account, not a coin that could be held in the hand.

3 Written in 1965, before the UK had decimal coinage.

4 See Simpson, A D C, & Connor, R D, Weighing in the Early 14th Century, *EQM*, p 1987-98 and 2015-24.

5 Ordinary people were brought into contact with the Troy system regularly because bread was weighed in Troy units.

6 The editor would like to publish the evidence on Nuremberg scales being supplied to Hanseatic merchants.

7 Pommier, A, *Inventaire des Poids*, CNAM, 1989, p 58, 133, 203, 204 & 205 shows details of designs permitted.

8 Plumb-bob: a lead (*plumb* was the Old English for lead, from the Latin *plumbum*) lump on a string.

9 The editor would like to publish evidence relating to a wooden wedge. Bismars were commonly suspended from a cord slung under the beam, with a wooden handle above the beam. See EQM, page 1030.

10 Albrecht Durer showed equal-arm beams with knife-edges in some of his etchings done around 1500.

11 Presented to the Academie des Sciences in 1669/70.

12 See EQM, page 197.

13 See EQM, page 1664.

Part 3 of this article will be in the next EQM.

Not Shekels but Ounces

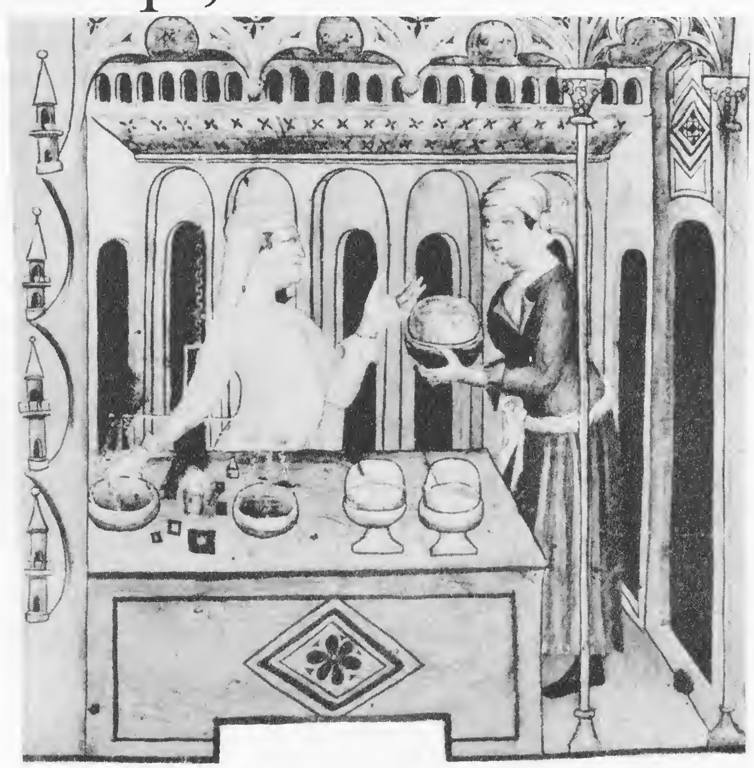
BY G ZAVATTONI

As the proud new owner of the Roman weights shown in *The Science of Weighing Yesterday*, Part 1, Fig. 16, page 2148, I would like to inform you that the weights are not in shekels but in Roman ounces. In particular, the smallest is 2 oz, then 4 oz, 3 lb, 5 lb and 10 lb. The largest weight was orinally 50 lb but was cut down to approximately 35 lb.

Note from the Editor:
This points up the necessity to test weights before putting them into auction, so that the auction-house can produce an accurate catalogue with the help of the vendor, as Gerard Houben and Albert Rangeley (amongst others) so notably achieved. Occasionally an auction-house has enough man-power to weigh, give a detailed description of marks on each weight, and research them, but that is unusual. The person bidding for the objects in auction must get some surprises when receiving objects bought after only reading an auction-catalogue, and this explains why auction-houses recommend handling the objects before bidding. Several members of our society help by doing the examining, and then reporting back to their friends and customers before a sensible bid is arrived at. This is a service that depends on the knowledge and experience of these members, and must be recommended.

Mediaeval Manuscript, 1300s

From the *Taccuinum Sanitas,* painted in Lombardy, Italy, during the 14th century.



It shows a plump butter merchant with one hand gesturing towards the bowl of butter that he is selling to his voluptuous customer, and the other hand resting on one scale-pan. His stall appears to be in a grand stone building where the sun would not melt his butter. The scales are difficult to pick out, but the square-shouldered shears are clear. The chains for the pans and the chain hanging from the ceiling show well. The weight near his hip is visible, being tall and round with a conical top, like the bigger weight between the pans. The tiny objects on black squares are not identified.

J H Becker, a Response

BY R HOLTMAN

Although the Julian H Becker scale (pp 2164-5) came from a Dutch workshop, I have not yet seen this type of quadrant scale in Holland. Only a few weeks ago, I was turning over the leaves of my copy of the Julian H Becker catalogue c.1934 and was attracted by the same scale. Fig.1 is that scale. Fig. 2 is a translation of the text.

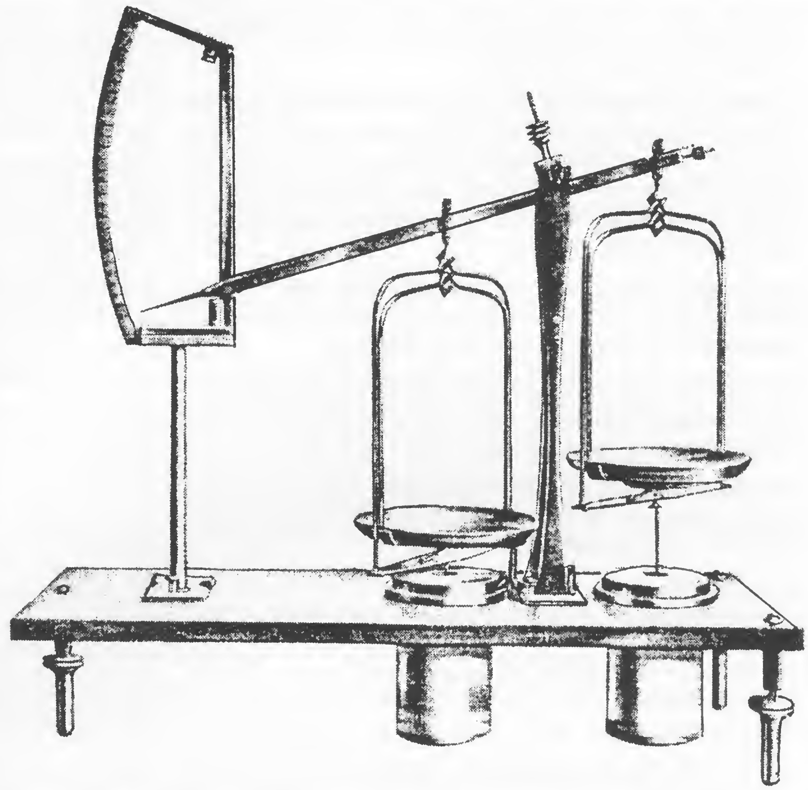


Fig. 1. Version of the J H Becker scale in the catalogue of c.1934.

Meten & Wegen published a long article on the Beckers by the late Louis Walters, on pp. 1876-1884, 1916-1920 and 1943-1946. In it, Walters stated that Julian H Becker's firm was incorporated in 1926, and ceased production of balances c.1965. A catalogue and price-list of 1965 shows only a few, relatively simple scales and a good collection of weights. Earlier specification sheets, probably c.1950, show a *luchtrembalans* (literally, air-brake balance), but the dating is problematical, and might be as early as 1941, because a comparable fact sheet includes a certain pharmaceutical scale approved by the Dutch metrological service. The catalogue of 1934 shows basically the same scale, also with air-damping, and two pages later, a scale with oil-damping. And here comes the difference between the air- and oil-damped:- both can be loaded up to 200 grams, but the air-damped scale with that load is still sensitive to $^1/_{20}$ mg, whereas the oil-damped scale is only sensitive to 5 mg.

Looking at page 700 of EQM, the late Hans Jenemann showed P Bunge's solution to the problems of prolonged swinging. Paul Bunge used a double hanger, similar to J H Becker's, but placed an air-damping piston below the pan to reduce the swings from a full drop to being stationary in a mere six swings, so that the scientist did not have to read by the deflection method of calculating the stopping position of the pointer, but could read the stationary pointer against the ivory arc.

Jenemann's assertion (on EQM p 702, and also published in *Die Waage des Chemikers* on page 50) that C Becker used an air-damping system in the base is probably a confusion between Christian Becker of Delft and Becker's Sons of Brummen or Rotterdam. The same scale is mentioned in a Dutch-language catalogue of 1919, by Becker's Sons of Brummen, and also in a French-language catalogue of 1913, by Becker's Sons of Rotterdam. The text of the latter stated that the air-damping was based on the work of P Curie († 1906). *Grolier's Encyclopaedia* states that Pierre Curie constructed a torsion balance with a tolerance of 0.01 mg, but said nothing about air-damping. My Becker archive records Becker's Sons using air-damping up to 1965, or just before.

Becker's Sons was incorporated in Rotterdam in 1872 by Henri Louis Becker (born 1848) and Julian Johan Becker (born 1849). H L Becker left the firm in 1895 and incorporated H L Becker Fils in Brussels. In 1912 J J Becker moved to Brummen (near Arnhem): the workshop moved in 1914 to Brummen and the office eventually moved to Brummen in 1918. In 1967 the firm was bought by Simmonds Precision; around 1975 the production of scales was discontinued.

Quick Weighing Quadrant Balance

These balances are distinguished by their quickness, combined with high accuracy and time-saving.

To avoid the inconvenient swinging of the pans, and by that affecting the movement of the beam, thin metal cylinders are fitted below the pans, hanging into the oil-dash-pots. The cylinders brake the balance in such a way, that the slowing down is aperiodic and thus the balance reaches equilibrium and comes to a standstill within a few seconds.

The balances are mounted on an iron base and fitted with adjusting screws and level. The double hangers avoid the possibility that the cylinders will rub against the walls of the glass pots.

Direct readings are taken on the divided scale sector, which not only saves a great deal of time, but moreover it reduces mistakes to a minimum.

For weighings starting from the (maximum) value of the divided scale up to the capacity of the scale, brass weights are placed on the pan between the quadrant and the pillar.

The advantages of these balances are:
- no use of milligramme weights and small brass weights
- big time-saving
- easy read-out, no mistakes with small weights
- high sensitiveness
- high accuracy

Thanks to the time saved with this, our quick weighing balances are successfully used for chemical laboratory work by university and industrial laboratories.

No. 406 Capacity 1000 gramms in each pan, sensitivity 50 milligramme, can be estimated to 25 mg. Scale sector 22 cm long, divided into 200 parts. As you can directly read from the quadrant weights up to and including 10 grammes (without using weights), every division is worth 50 mg, so that 25 mg or less can be easily estimated. Code word Olierap.

No. 407 Capacity 1000 gramme in each pan, sensitivity 40 milligramme, can be estimated to 20 mg. Scale sector 22 cm long and divided into 125 parts. As you can read directly from the quadrant weights up to and including 5 grammes, every division is worth 40 mg, so that 20 mg or less can be easily estimated. Code word Olitrapt.

No. 408 Capacity 100 gramme in each pan, sensitivity 5 milligramme, can be estimated to 2½ mg. Sector scale 22 cm long and divided into 200 parts. As you can directly read from the quadrant weights up to and including 1 gramme, every division is worth 5 mg, so that 2½ mg or less can be easily estimated. With a view to its high sensitivity, balance No. 408 is delivered in a polished hard Cuban mahogany case with push-up front door with counterpoises. Code word Olika.

Fig. 2. J H Becker catalogue of c.1934.

Translation by R Holtman

Julian H Becker (son of Julius Johan Becker) was born in 1883 and died in 1954. Julian H Becker - Rotterdam was incorporated in Delft in 1926, and moved to Delft in 1928, changing its name to N V Balansen- en Gewichtenfabrick van Julian H Becker. The real human Julian H Becker took control of the firm a few years after the incorporation. After 1945 the name was changed to Becker Delft.

My sources were the article of the late L Walters, used with permission from Riek Walters, and *Instrumenten, Wetenschap en Samenleving*, a thesis by J Mooij, 1988.

Author's Biography

Ritzo Holtman is the Editor of *Meten & Wegen*, Gewichten en Maten Verzamelaars Vereniging, the superb journal of the Dutch society of weights and measures collectors. He is particularly interested in mediaeval weights.

Contemporary Comment, 1823

From *The Mechanic's Magazine*, London, 1823, p 175.

A new steelyard has been invented in France, which is said to possess greater accuracy than the description of that machine hitherto in use. One of the improvements in the new invention is the ease with which it can be verified. The divisions, which are marked on the long arm of the beam, begin from a **zero** point; that is, from a point at which the travelling weight places the machine in exact equilibrium, when no weight is attached to the short arm of the beam. This enables the most ignorant persons to judge at once the correctness of its construction.

Dr. C H Fitch dates

BY J KATZ

Listed in Thomas's *Register of American Manufacturers*, 1905-1906 Edition, is the Randolph Paper Box Company, Richmond VA, as maker of a Prescription Pocket Scale. That is none other than our famous Dr. Fitch's scale. The EQM article does not cover just how long Dr. Fitch's scales were made (regardless of model and other makers). This information now at least puts a bound on the "made at least until" question, until other evidence present itself.

Also, under the caption of Fig. 7, EQM p 2045, the carrier more correctly "dampens beam oscillations" rather than "checks vibrations".

[Ed.note: You are correct, of course. However, as noted in the fine print on page 2049, we quoted the exact terminology of the patents in order to reflect the linguistic habits of late nineteenth century America.]

More Reflections on Dr. Fitch

BY L MARSON

Equilibrium readers often find informative articles of interest in this periodical. In the 1996 issue 3, my attention focused on the papers about Dr. Fitch's scales. W Doniger's narrative of his findings refreshed my memory of a parallel experience in obtaining my first 1885 model of Dr. Fitch's scale in New York in 1960, when I was a beginner among the few apothecary weights collectors. Seeing Fig. 1 (EQM p. 2054) in D Crawforth-Hitchins' *Dr. Fitch's Descendants* reminded me of finding my own first plastic scale in grams and carats in 1980.

These items had a special appeal to me for the ingenuity of their construction and, as a corollary, they are gadgets pertinent to my pharmaceutical background. I admired W Doniger's perseverance in perusing the patents' relevant history and analyzing the various mechanisms. Yet, aside from the exciting aspects of that investigation, I found even more stimulating R Willard's observations in the well-articulated *Reflections* and I enjoyed her analysis of the historical context.

As she said, Dr. Fitch aimed to provide a portable scale for travelling doctors, but pharmacists of that time felt no need for a portable prescription scale. However, because this was an era of preparing medicines in the pharmacy for each individual patient, Fitch extended the practicality of his invention to the pharmacist by presenting his 1888 "improvement" with a changed name, from prescription scale (for doctors) to prescription weighing-scale (for pharmacists). The increased capacity of the 1888 model served to extend the scale's marketability to multiple-dose compounding and non-medical applications, and perhaps also for export, if a metric graduation was accommodated. Fitch made the same distinction between his two subsequent versions, the pocket-size 1890 prescription scale and the larger 1895 prescription weighing-scale.

It seems that the scale's easy portability was viewed by Dr. Fitch as a convenience of shippability. However, the 1888 patent's objective: *it may be disassembled and its parts packed in small compass for transportation*, repeated at the end by calling attention to *the facilities for disassembling in order to pack it for transportation*, was omitted from the 1895 patent. Probably, high precision combined with transportability was no longer viewed as a novel combination having importance to an item conventionally perceived to be stationary.

The prices in the 1897 Langley and Michael's catalogue[1] (EQM p 2049) suggest that the poor sales of the 1888 combination model, (which undoubtedly contibutes to its rarity today) was not due to cost but rather to the three main points that you skillfully outlined. Nonetheless, I would like to suggest that in

Fig.1.McKesson & Robbins catalogue of 1883, page 104. [The page had large white spaces removed by the editor.]

McKesson & Robbins' Illustrated Catalogue.

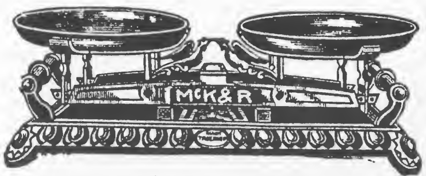


Fig. 2710.

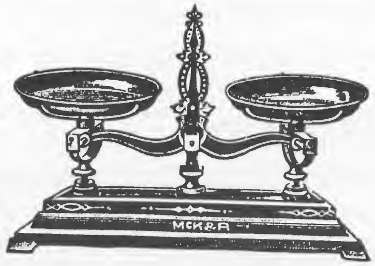


Fig. 2720.

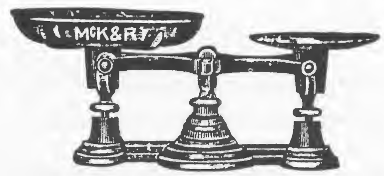


Fig. 2723.

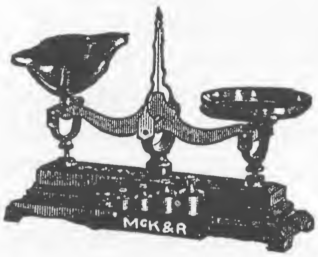


Fig. 2725.

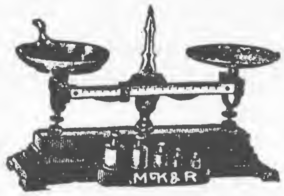


Fig. 2726.

Fig. 2730.

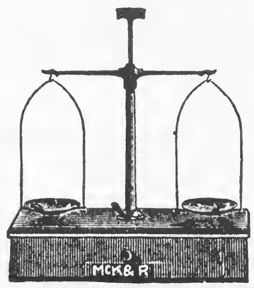


Fig. 2736.

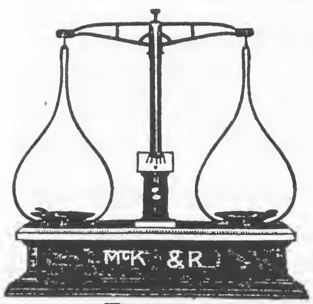


Fig. 2735.

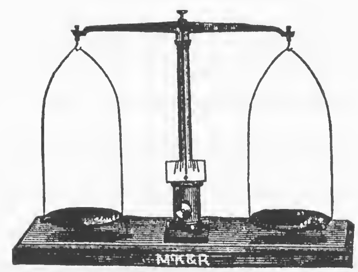


Fig. 2740.

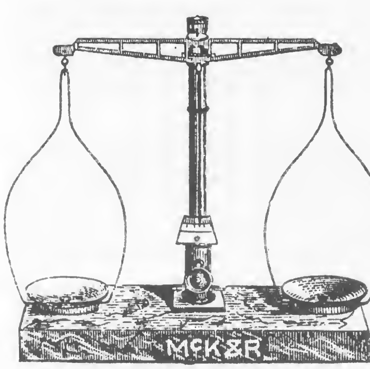


Fig. 2741.

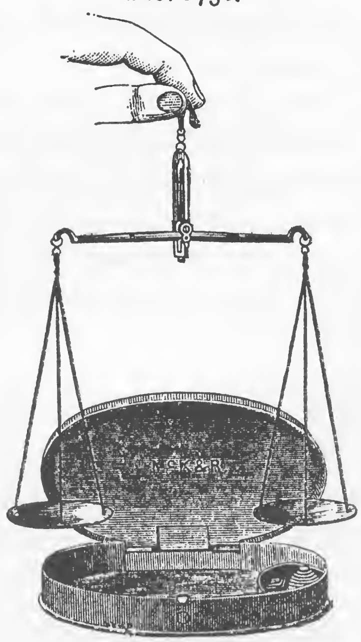


Fig. 2745.

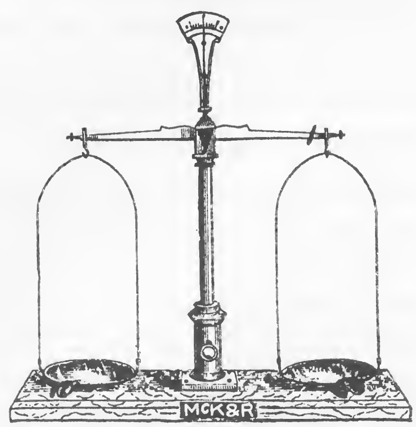


Fig. 2746.

Each cut represents one-ninth the size of the original.

The above Scales are from the celebrated manufactory of Henry Troemner.

reviewing prices for scales during that period, there is an additional source of comparative information: pharmaceutical equipment catalogues.

A 1959 study, including a chronological bibliography, names all the pharmaceutical catalogues known to have been published in the US from 1760 through 1890 and gives the locations of libraries holding copies of each title.[2] Only three catalogues were published in the 18th century. The first half of the 19th century produced 10 such catalogues spaced at intervals of several years. Yearly issues are known between 1850 and 1891, with a total of 104 entries recorded during that period. According to the authors, the catalogues seldom carried illustrations until after 1850, but by the 1870s they were often profusely illustrated.

However, the only listing in the bibliography that specifically mentions illustrations is the *McKesson and Robbins Illustrated Catalogue* that was specially issued to accompany the regular Prices Current of the same year. I am fortunate enough to own a fragile copy of that catalogue, but have never seen a copy of the 1883 Prices-current. This catalogue is important because it shows on page 104 (Fig. 1) some of the H Troemner pharmacy scales on the market in 1883, two years before Dr Fitch applied for his first patent. In consideration of the time required for composing, printing, and distributing the catalogue, I believe that the pictures represent items that were actually manufactured or sold in the preceding year or even earlier. In Plate 1, Fig. 2723 closely resembles your Fig. 3, EQM p 2050, a Fairbanks scale for which you have shown an 1891 price; Fig. 2710 and Fig. 2730 are essentially equivalent to the Troemner models, Fig. 5 and Fig. 6, EQM p 2051, which you have dated and priced for 1899. Although prices may not have changed during a 10 year span, it may be possible to effect a more accurate chronological comparison.

This effort will require input from other members. According to the bibliography, original copies of both the catalogue and the price list are to be found at the Massachusetts College of Pharmacy in Boston and the Wisconsin University School of Pharmacy in Madison. A copy of the catalogue only is available at the Minnesota University College of Pharmacy in Minneapolis; the price list only is available at the Corning Glass Center, Corning, NY. Can any reader supply a copy of the price list (McKesson & Robbins, Prices-current. New York, 1883, 480 pp.)?

Now I should like to make a few side-line remarks. Firstly, it is very informative that for your Fig. 6, p 2052, you have shown a model made for domestic use, supplemented with EQM citations showing the *Made in America* legend that indicates manufacture for export.

Secondly, in your list of references you cite some undated commercial catalogues. For them, it is sometimes possible to give an approximate date within a 10 year period. For instance, at reference 5, my guess is that the *Eimer and Amend Catalogue* may be of the 1930s or the post-World War II years, because the earlier issues are rare. If the cover of the book gives a number or a letter following the word *Catalogue* in the title, it is likely that the catalogue be of the World War I or of an earlier period. A range of prices can then confirm such estimated age of the catalogue.

My compliments again for the outstanding discussion and provocative observations expressed in your appendix article, and thank you for letting me share these notes with you.

Notes and References

1 A rare catalogue such as the Langley & Michaels Co., Importers, Wholesale Druggists, and Manufacturing Chemists, 1897, may be the only known nineteenth century pharmaceutical catalogue from San Francisco. If a second copy exists in a public library, information about its availability would extend its value to lovers of antique artifacts and literature.

2 Griffenhagen, G B &. Romaine, L B, Early U.S. Pharmaceutical Catalogues, *American Journal of Pharmacy*, Jan 1959, Vol 13, No.1, p 14-32.

[Ed. Note: We thank you for your thorough analysis and knowledgeable comments. We are delighted to learn of this new source of information. Until receiving your article, we never thought to investigate the selling price of the Fairbanks steelyard that may have been the inspiration for Dr. Fitch's 1888 Combination Scale. The 1906 Fairbanks' catalogue offers those Prescription Scales in two styles and four price levels ranging from $5.00 to $11.00. In 1919 the price was $10.00. This information leads to the conclusion that cost may have been a factor in the commercial failure of Dr. Fitch's 1888 combination Scale. Fairbanks' more effective marketing network may also have played a role.]

Author's Biography
Lucio Marson received a doctoral degree in pharmacy from the University of Padua and practised the profession in Udine before coming to the United States in 1949. Here, he worked in retail pharmacies and in private industry, later receiving a graduate certification in industrial pharmacy at Columbia University. He was employed by the Department of Defense as an industrial pharmacist and quality assurance chemist for military contracts in the US, Europe and Asia until he retired. He wrote more than 30 technical papers in the fields of chemistry and pharmacy, is an officer of the Postal History Society, and a philatelic contributor to the Italian Academy of Studies. In addition to antique pharmaceutical scales, he collects early mediaeval posts, Venetian Republic handstamps, disinfected mail, and military mail of the Vietnam period. He attributes his curiosity about the past to his family's pharmaceutical experience of more than three generation combined with foreign travel later. Scale collecting, he says, is a peculiar hobby *for fun.*

Ohaus: Dr. Fitch's Descendant?

BY J YOUNG

EQM, p 2055 Fig.4, shows an Ohaus model 10•10-10 precision balance having a capacity of 101 x 0.01 grams, and asks the question, "*Can any member identify the function of the knurled knob on the left with the loop of wire protruding from the top?*" I think I have an answer and a few comments for your readers.

1. The knurled knob is used to level the scale base, which has the effect of raising or lowering the indicating chart to attain zero while the weighbeam remains in the same position as it was, level. This allows the user to adjust the zero for out-of-level conditions.

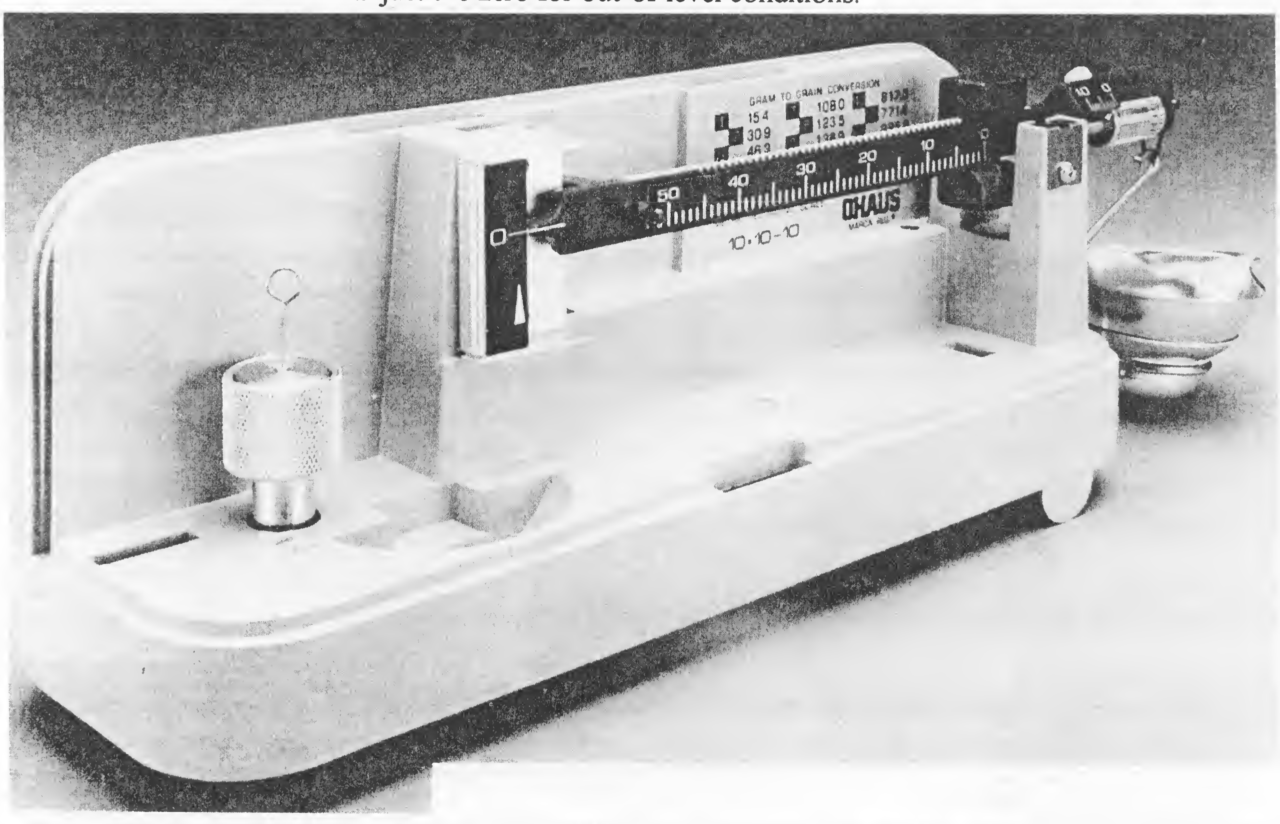
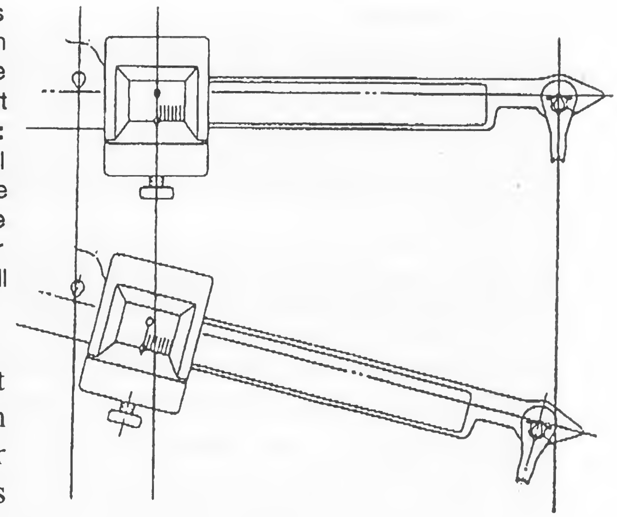


Fig. 1. Portable 10·10–10 Ohaus balance. The knurled knob is nearest to the camera. The aluminium pan will hold powders, solids, small animals and liquids, and is anodized for no-stick pouring. Picture from the Ohaus brochure

Fig. 2. ➢➢ When the scale is set up for use, and no changes have been made by anyone, with all poises set to zero, the beam is level. What the user does, when changing the angle of the base with the knurled knob, is raise or lower the indicating chart to attain zero. The beam remains in the same position as it was: level. If the beam on any steelyard is not level at zero all weighings will be in error, at least theoretically. This is because the distance between the fulcrum and the poise or the loose poise's hanger at the tip of the beam (if there is one) are at their greatest distance only when level. Any change from level will shorten the distance introducing an error in the weight recorded.
Drawing J Young



2. It is also used as a "nest" for the 50 g attachment weight. The "loop of wire" is actually the hanger on the weight. The attachment hangs from a "pivot" near the end of the weighbeam. When attached it increases the maximum capacity to 101 grams.

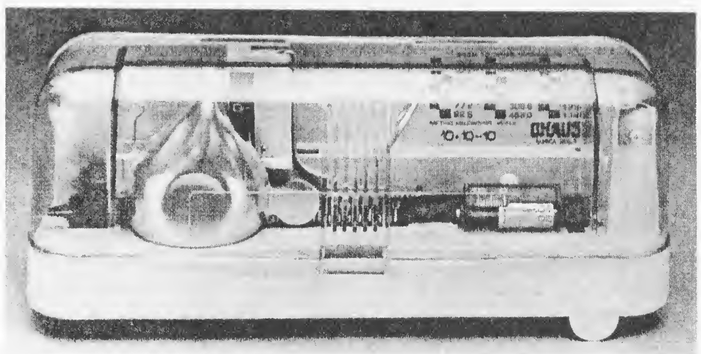


Fig. 3. The 10·10-10 beam and pan detach and store in the base. The snap-on protective cover keeps dirt out, and forms a compact carrying case. Picture from the Ohaus brochure

Please note that the minimum graduation is 0.01 gram, not 0.1 gram. This scale is by no means intended for prescription weighing, as stated in the article. As specified in the Ohaus brochure, it is intended as a portable scale for field work in biology, earth science, and other environmental studies, and designed for use in arts, crafts and general hobby work where high precision is required. It is a very well-made instrument, incorporating agate bearings, hardened "knives" and magnetic damping.

As far as I know, this scale is a current production model.[1] Similar Ohaus models are used for gun-reloading operations among other things and are gradutated in grains with a sensitivity of 0.1 grain. The gun-loading scales are green in color and sold under the name RCBS.

Directions for Use and Maintenance of the Model 10·10-10, Ohaus Corporation, 1983:

Your balance is equipped with magnetic damping which causes the beam to come to rest quickly without affecting sensitivity or accuracy. It operates on the principle of a permanent magnetic field resisting the motion of a non-magnetic, copper damper attached to the beam.

The pole faces of the damping magnets are positioned on both sides of the 6mm wide slot that the damper travels in when the beam is in place.

The only maintenance required is to keep these magnets free of of magnetic particles which could interfere with free movement of the copper vane. Should any debris collect in the magnetic area, it can be removed by using a piece of adhesive-backed tape.The magnetic damping is effective at all loads and will speed up weighing.

Notes and references

1. US patent no. 227,700, issued July 1973 refers to its appearance rather than its technology. M Drury of the Ohaus Scale Co. reports that the current production model 10·10-10 was first registered as design patent 234,582 on 25 March 1976.

D Crawforth-Hitchin's comment:

Having only seen this scale in the collection of Horst Winskowski for a few moments when visiting Germany in 1978, I was privileged to be lent an immaculate example of this scale by Jack Young. This stimulated great interest when shown at the Los Angeles Convention in May 1997, particularly concerning the magnetic damping that Ohaus employed. Several members contributed to the discussion, including Leslie Hitchins.

Author's Biography
Scales have been a part of Jack Young's life since childhood. By the age of 13 he was working part-time in his father's firm, a Toledo distributorship in Raleigh, NC. After qualifying in accountancy and investments, and working in each profession, he returned to the business that was to be his life's work:- selling and servicing scales. He bought his father's business in 1959, sold it in 1970, and opened a new dealership in Honolulu. Since selling that business in 1991, he continues active scale work on a very limited basis during yearly visits to Honolulu, Siapan, Tinlan and Guam, where he calibrates concrete and asphalt batch plants as well as a few truck scales. He generously shares his expertise when consulted on EQM articles in preparation.

Magnetic Damping

BY L HITCHINS

Being surrounded by scales, I am forced to take some interest in them, and this usually takes the form of delight at the ingenious application of various physical principles in their construction. One of these, magnetic damping, was mentioned in the article *Dr. Fitch's Descendants*, which included an Ohaus scale on p 2055. Here is a brief explanation of how it works.

When a conductor, such as a length of wire or a copper plate, moves in a magnetic field it generates an electric current - this is the principle behind electric generators and power stations, where electric current is produced by causing coils of wire to rotate in a strong magnetic field. However, one of the fundamental principles of physics is that "there ain't no such thing as a free lunch" - the current generated comes at a price of resistance to the motion (in the case of an electric generator, there needs to be a motor forcing the coil to turn against the resistance).

The resistance to motion in a magnetic field is used for damping on the Ohaus scale. As with oil-damping, the faster the beam is oscillating, the greater the resistance, and as the oscillations slow down the resistance becomes finer and finer. I presume that magnetic damping can be made more compact and easier to set up, with less likelihood of mechanical problems, than air- or oil-damping.

The vane and the mounting which move in the magnetic field must be particularly non-magnetic, or error will be introduced by attraction to one of the magnetic poles (the Ohaus scale has a copper van attached to the aluminium beam, which meets this criterion). The copper vane does not show in the picture on p 2055, because it is in the slot behind the graduated plate. The beam appears to come in front of the graduated chart, and so it does, but it also has a bar attached to the back of the beam, with the copper vane attached to the bar (essentially making the beam bifurcated). The copper vane does not touch the two magnets, but swings freely between them.

Error can be introduced when attempting to weigh magnetic material - in the case of the Ohaus, this is minimised by having the scale pan at the opposite end of the beam to the magnets.

Eddy Current Damping (Dr L Biétry, in *Mettler's Dictionary of Weighing Terms*, 1983)
A nonmagnetic, electrically conductive (copper, aluminium) damping vane which, rigidly attached to the oscillating system, moves between the poles of a magnet. The eddy currents created in this manner convert the kinetic energy to an electric heat loss.

Electromagnetic Damping (Hans Jenemann, in *A Short History of the Development of the Scientific Balance*, Jungingen1977, translated by Prof. H C Boulton)
Even quite early an interaction between the mechanical principle of the lever [pendulum] balance and electromagnetic effects was established. Thus, in 1866, A Cazin described an electromagnetic balance in order to display the correctness of the fundamental law of electromagnetism in current-carrying conductors. In 1895, K Angström developed an electromagnetic compensation balance for the measurement of very small masses. A balance was described by Marek in 1906 using eddy-current-damping acting through a magnet. In this, a plate of a good conducting, absolutely unmagnetisable

metal, e.g. aluminium, moved in the field of a permanent magnet. Electric eddy-currents arose in the plate which led to a quick damping. The damping was done only occasionally by magnets; because iron may not have been wholly absent, as small particles, it was a worry that the equilibrium position may not have been reproducible. Whilst this damping principle found no widespread application in Middle Europe, it was able to penetrate widely into American laboratories, beginning in the 1930s.

Author's Biography:
Leslie Hitchins married the editor in 1990, and got dragged into the manic world of collecting much against his Quaker principles, but he willingly gives help and advice on the production of EQM. He does conservation work, runs organically an allotment [vegetable plot], bicycles whenever practical, loves Scottish country dancing and international dancing, and reads avidly. He is Treasurer of Headington Society of Friends Meeting. He programmes computers for part of the Blood Transfusion Service and for other parts of the Health Service.

Gerald's Advert, 1844

BY A YALE

On the back page of EQM, p 2168, was an 1844 advertisement for Gerald's Patent Platform Scale, with a note requesting any information relating to Gerald. In the Fairbanks papers at the Vermont Historical Society are at least eight letters which mention the firm of Gerald and Farr, scale makers. In January 1839, Fairbanks' Philadelphia agent complained that he was being undersold by the firm of Gerald and Farr. Three months later this same agent complained that Gerald & Farr was providing brass beams and brass weights at a price lower than for a comparable Fairbanks scale. A letter from Fairbanks' Hartford agent, apparently responding to a query from St. Johnsbury, states that he "*cannot ascertain that Gerald & Farr have any scales on sale here.*"

The remain five letters refer to a lawsuit by Fairbanks against the firm of Gerald and Farr of New York relating to patent infringement. Nehemiah H Fletcher, a Fairbanks agent, was attempting to find out what Gerald & Farr's defence would be in the infringement suit. Fletcher initially approached Gerald & Farr incognito, but was eventually found out. He provided Fairbanks with a list of witnesses Gerald and Farr intended to call to testify "*that the same kind of scales were in use in nearly all the States and England and France long before they were manufactured by you* [Fairbanks.]"

A letter, dated February 17, 1840, addressed to E Fairbanks and signed by A Gerald of 762½ Greenwich Street, New York, New York, mentions a meeting the two had at Whitehall, New York. Gerald writes: "*from your conversation I presume it was your desire to have the suit you commenced settled amicably & without further expense.*" From this last sentence it can be inferred that Fairbanks recognized the futility of defending their original patents and were trying to exit the suit gracefully.

In August of 1840, Fairbanks' New Orleans agent asked whether Fairbanks was pushing its suit against Gerald and Farr as competition from firms infringing on the Fairbanks patents was interfering with business in New Orleans and other western cities.

It is possible that the Gerald of Gerald & Farr is the same individual who produced the 1844 advertisement. If that is the case, it would appear that his partnership with Farr had dissolved between 1840 and 1844 and Gerald had moved from Greenwich Street to Barrow Street. The other possibility is that there were two Geralds producing scales in New York City during the 1840s.

Author's Biography
Allen Yale holds a BA degree in anthropology from Yale University (1964), an MA in history from the University of Vermont (1983) and a PhD in history from the University of Connecticut (1995). He taught high school for about 20 years before beginning his doctoral studies.

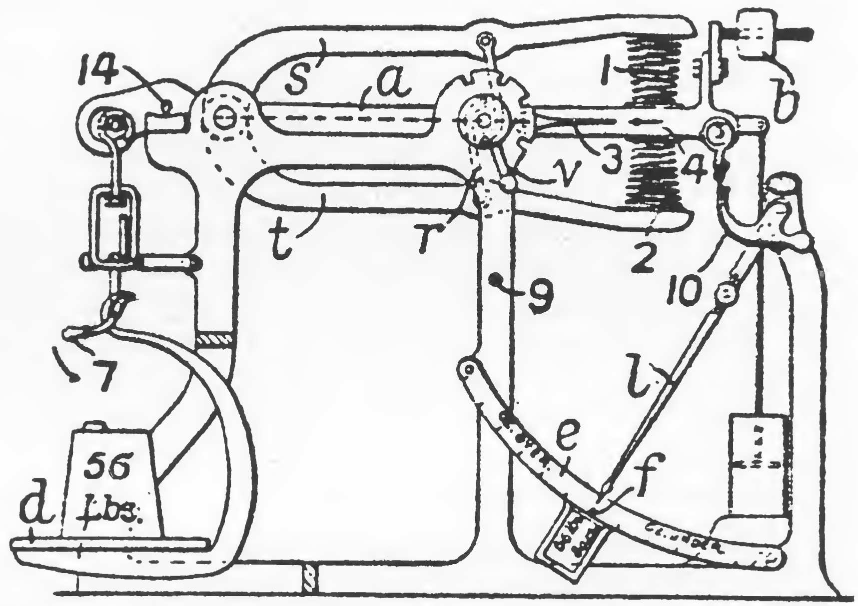
He began collecting scales after choosing the topic for his dissertation and now owns about 50 scales, mostly Fairbanks. He is currently an assistant professor of history at Lyndon State College, whose location about 10 miles north of St. Johnsbury allows him to continue his studies of the Fairbanks company.

Is this Damping?

BY D F CRAWFORTH-HITCHINS

Hutchinson's Scale Co took out a British patent on 12 Sept 1910, which primarily related to a means of reducing the oscillations of a steelyard during approximate weighing using springs. The full text is used here, and any member who has seen, or can tell us more about this mechanism, is invited to write to the editor. Any information relating to the company, dates and nationality, would be most welcome.

Pendulum-weight apparatus.-



Relates to a weighing-scale by means of which an approximate weighing is first made before the more delicate mechanism for the final weighing is used, and the invention consists primarily in providing means for gripping the scale beam during the approximate weighing.

*In the scale shown in the Figure, the beam **a** mounted on a fulcrum **14** preponderates on the right-hand side by a little over 56 lb with the adjustable weight **b** in the position shown. A loaded pointer **l** and flexible band **10**, such as is described in Specification 14,495/09, are attached to the end of the beam and are used during the final weighing.*

*In weighing out 56 lb 8 oz of butter, the pan **d** is lowered on to the table by turning a handle 7, the loaded pointer **l** is supported on a peg **9**, a pair of levers s, t, are drawn together by turning a handle **v**, so as to grip the beam between a pair of springs **1**, **2**, the butter is placed on the pan **d**, the pan raised into gear, butter removed or added until a mark **4** on the beam registers with a fixed pointer **3**, the peg **9** removed, and the beam released from the springs **1**, **2**. The butter is then finally adjusted until the pointer **l** registers with a mark f on the centre of a scale **e**.*

Notes & Queries

N & Q 132	from A CRAWFORTH

This lead object, found in England, might be a Mediaeval weight. Can any member confirm this? It weighs 7373 grains (477.6 grams) and seems relatively complete, being little worn. It measures 2.15 x 0.9 ins (54 x 24 mm). The lightly-scored pattern on the top appears to be a square divided into quarters. The lower right quarter is further divided into quarters. The other three quarters have indistinguishable markings. The bottom is smooth and unmarked. It seems too heavy to have been a London spice-pound. So what is it?

Photo D Crawforth-Hitchins

Contemporary Comment, 1849

From B DONIGER

This letter was sent to Messrs E & Fairbanks & Co, [sic] Nr 81 Water st New York by W S Johnson in San Francisco. Because the hand-writing is very difficult to read, it has been transcribed:

San Francisco
Nov 30th 1849

Messrs E & T Fairbanks & Co,

Dear Sirs

I enclose Bill of Exchange on Howland & Aspinnall Ltd for $500. on a/c of first consignment of which several of of [sic] the largest size are yet unsold.
The Invoice for Registers is just landed amidst the most difficult circumstances a man had ever to contend with The streets are nearly impassable & I employed men to transport them on their backs as the cheapest way to get along with them. - On opening the counter scales they are found to be wet & rusty
I have written to my brother to have you send out 3 - Iron Hay scales to weigh 4 Tons with the Lumber all fitted complete to set up - An immense trade in hay is done at Sacramento City San Francisco & Stockton and I want one for each - Not only for hay but to weigh waggons ready loaded for the mines will afford great profit & commission [convenience ?] - I wrote you some months ago about gold scales the druggist do not give confidence for that purpose besides they should be divided in Dollars instead of pennyweights. - The Even Balances should weigh 15 to 20 lb & they would go better Grocers & Counter are all right. - The next invoice may be assorted as follows
No 12. Grocers, Counter, Even Balances,
10 - 50 - 50 - 30 - or in that proportion. -
There will be a great demand next season for them

Very truly yours - in haste W S Johnson

Please say to Messrs Fairbanks & Co that I have recd the invoice for Vernon at last & taken them to Sacramento City where I shall be able to give a good account of them.

Editorial comment

Several interesting points occur in this letter. W S Johnson was writing to the New York department, rather than to Head Office in Vermont, because Fairbanks had only four warehouses then, at Boston, New York, Philadelphia and Baltimore.[1] One might deduce that ships sailed more regularly from New York to California than from the other ports.

An agreement, to make W S Johnson the agent of Fairbanks, was made between *Johnson & Co* and *Fairbanks & Co*, New York, on 21 Jan, 1849.[2] So the reference to the "first consignment" in the first paragraph above was exactly that, the first Fairbanks scales to be sent out to California for sale by their own agent.

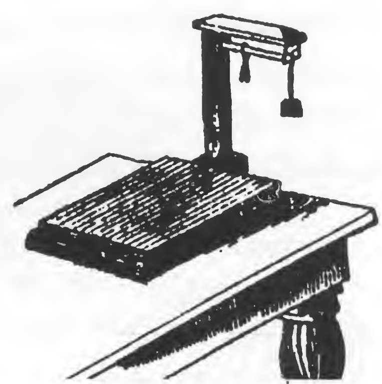


Fig. 1. Johnson ordered 10 of this no. 12 scale, a platform counter scale with a short pillar, capacity 240 lbs, with platform 19 x 13 ins (475 x 324 mm), price $12 retail.

The reference to "the mines" is a cool comment on the frantic attempts to convey goods up to the gold-miners in their primitive

shanty-towns, thrown up during that year, and certainly affording "great profit" to level-headed men who made their living supplying the miners, rather than joining them.

It is interesting that Johnson had been selling druggists' scales for the weighing of gold.[3] As Fairbanks offered many varieties of druggists' scales, it is impossible to know which type Johnson was offering. Johnson's suggestion that miners wanted to weigh gold by the dollar's-worth seems never to have been adopted. Of course, that would have required that gold prices stayed constant.

Notes and References

1 Yale, Allen, *Ingenious and Enterprising Mechanic*, Ann Arbor, 1997, p 145.

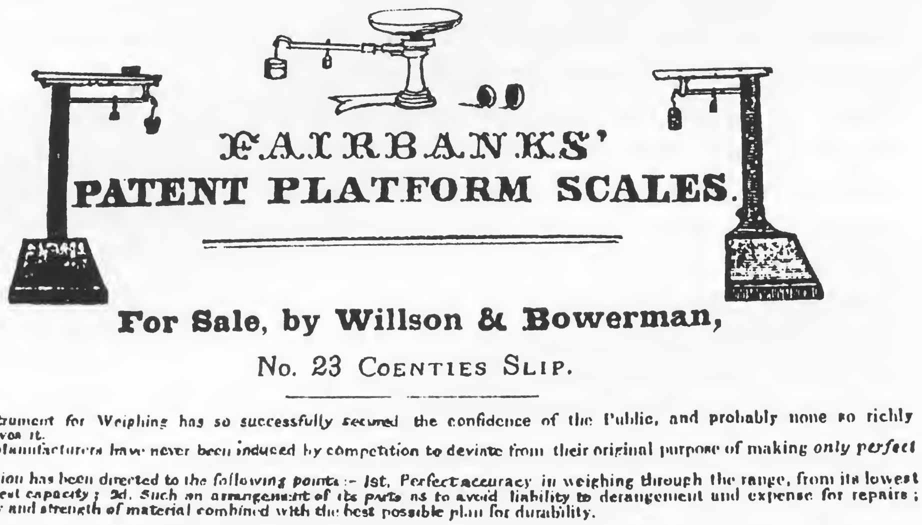
2 Yale, Allen, *Ingenious and Enterprising Mechanic*, Ann Arbor, 1997, p 142.

3 Doniger, W, Scales of the Gold Rush, <u>*EQM*</u> p 151-158.

Old Advert, 1841

From W DONIGER

From Hunt's *Merchants' Magazine and Commercial Review*, XXVIII, New York, Oct, 1841.



Editor's Comment

The statement above that *The Manufacturers have never been induced by competition to deviate from their original purpose of making only perfect balances* gives us a glimpse into the cut-throat world of trade scales in the Eastern States in the 1840s. Fairbanks reacted with dignity to competition, but backed it up with law-suits regularly.

The book by Allen Yale, reviewed on the next page, has an excellent section on Fairbanks' use of agents, and the careful control that Fairbanks exercised over those agents. To quote Yale:-

> Hiram Knapp remembered the selecting of this initial group of agents [in about 1832], characterised as "*men of great energy, reliability and industry*." These were "*furnished with a very carefully prepared letter of instructions [and]....a set of drawings in water-color, of different parts or sections of the scales, to aid in effecting sales, and a plan and model of the scale*." Erastus Fairbanks provided them with written instructions and personally conducted correspondence with them.

Yale records that Fairbanks, by 1833, had a partnership for selling their machines in New York state, under the name of Fairbanks, Stevens & Co. This partnership served a network of local agents. Were Willson & Bowerman one of these local agents?

Review

Ingenious and Enterprising Mechanics: A Case Study of Industrialization in Rural Vermont 1815-1900, by Allen Rice Yale, Jr, Ann Arbor, 1997. 380 pages, 65 illustrations, 11 maps, 13 graphs and charts, 22 tables, 6 appendices, glossary. Copies are available only from UMI Dissertation Services, PO Box 1346, Ann Arbor, MI 48106-1346 (1 800 521 0600 Ext 3781), as Catalogue No. 95-43892. Unbound copies printed on 8½ x 11" sheets are available for $29.50 total cost (no sales tax) through the Internet WWW.UMI.COM. Order by catalogue number. Prices for bound copies (postpaid) soft cover $57.50; hard cover $69.50; (these are the total prices for European buyers; US buyers must add their own state and local sales taxes). Academic price, soft cover $36.00 (plus sales taxes for US buyers); this price is available only to professors and graduate students in universities granting PhD degrees or European equivalent.

This is a comprehensive, objective study of the E & T Fairbanks Co, arguably the world's leading manufacturer of scales. As the first scale company history ever produced by a scholar who is neither an owner nor an employee of the firm, it incorporates information from a vast array of sources not usually consulted by company historians. It is the dissertation written by the author for his PhD degree at the University of Connecticut.

A dissertation? The very term is enough to scare away most hobbyists. While it is true that some of the material in this study will hold little interest for the average collector, the book is a gold mine of previously unknown facts, figures, and insights about the scales themselves, the patents, the companies marketing or distributing them under various versions of the Fairbanks name, their agents, their competitors, the manufacturing and marketing techniques that made them world-famous, and the impact of the company and its leadership on local, national and worldwide commerce, industry, and education.

Yale begins with the official company account of how Thaddeus Fairbanks, seeking an improvement over the clumsy steelyards being used to weigh wagonloads of hemp, *conceived the idea, wholly novel to him, of a platform resting on levers which embodied the principle of what is now known as the platform scale*. He then notes that within weeks of Thaddeus Fairbanks' death in 1886, Henry Little, a Fairbanks employee, wrote that he had previously told Fairbanks about seeing the above-ground portion of a platform scale in Boston several years earlier, but knew nothing of the lever system underneath. After a couple of days, he said, Fairbanks returned to him with plans he had devised for the lever system. Little then fabricated the scale except for the metal work, which Thaddeus had made. Others, too, have pointed out the prior existence of platform scales.[1]

A copyright 1878; B copyright 1893; C used c.1895–1935; D used c.1950 on; E used from 1980; F adopted 1994.

Getting a US patent was a simple matter before the patent reform act of 1835; one simply submitted a drawing and a description of the object. No proof of originality was required. Whether or not aware of those earlier inventions, Thaddeus and his brother determined to seek a patent and market the scales. For years, a copy of that first Fairbanks patent has been sought. Yale explains why none is available, starting with the original patent of June 13, 1831 being cancelled because of a defective specification and detailing all the problems up to 1837 and patent 118, a drawing of which appears in the book.

Almost overnight, the platform scale was being marketed all over the then-settled United States. In 1878, the firm proudly adopted its now-famous trademark, an image of the western hemisphere with a banner inscribed, **Fairbanks Standard**, symbolic of the role played by the company that claimed to represent more than one half the entire business of making scales and balances in the world. (Here's a clue for collectors: any scale bearing that logo can be dated 1878 or later.)

Aside from the novelty of the platform scale itself, what accounts for the phenomenal growth of the Fairbanks company? Yale attributes it to the Fairbanks' skill in acquiring or managing the three kinds of resources necessary for an enterprise to succeed--natural, human, and capital.

Having no access to the European craft-trained scale makers at work on the east coast, Yale demonstrates how Fairbanks relied upon local mechanics, who were receptive to innovative ways of doing things. The company was among the leaders in the development of what became known as the American system of manufacturing: the mass production of interchangeable parts through the use of single-purpose machines. As shown by their patent records, the firm was well-known for devising tools for specialized purposes: the pivot milling-machine, notching milling-machine, marking machine, and figuring machine. Each of these machines needs the adaptability to accommodate different kinds of scales and different national standards. Fairbanks also developed a system of adapting a basic scale to numerous uses by making some parts interchangeable among different models.

But the real genius of the Fairbanks company lay in its marketing strategy. Yale shows how the firm established a worldwide network of agents who were close to the customers, receptive to suggestions and requests for special orders, and able to report any innovative developments that they came across; consequently the company was quick to adapt to each new need. Excerpts from their correspondence provide insights into the human side of the scale industry.

Every work has some flaws, and this is no exception. The lack of an index, not considered proper in a dissertation, is a major inconvenience. Due to poor printing, the illustrations are just dark smudges. However, Appendix C, which lists every Fairbanks patent from 1831 through 1900, is worth the price of the book all by itself. And Yale gives us a very good read.

L Weiss

Notes and References

[1] Crawforth, M, (EQM p 655) mentions an illustrated article in the 1797 *Encyclopaedia Britannica* depicting a weighbridge invented by John Wyatt in 1740.

Lossing, B, *The American Century, A History of the Progress of the Republic of the United States in its First Century,* p 251, credits Thomas Ellicott, a Pennsylvania millwright, with fabricating a platform scale in 1822 for the Lehigh Navigation Co.

Apologies from the Editor

p 2143 Last line: 5,00 years should read 5,000 years.

p 2144 While presumably found in Upper Egypt, this scale has the ring and hole pivot beam ends invented by the Romans and used by several non-western civilizations up to the 20th century. See Crawforth's *Handbook of Old Weighing Instruments*, p 81.

p 2168, paragraph 2, Line 4, reads 'what was otherwise' but should read 'What otherwise'. The 'was' should be deleted.